metal finishing

PAINT APPLICATION, ELECTRODEPOSITION, VITREOUS ENAMELLING, GALVANIZING, METAL SPRAYING and all METAL FINISHING PROCESSES

Vol. 5 No. 58 (New Series) OCTOBER, 1959

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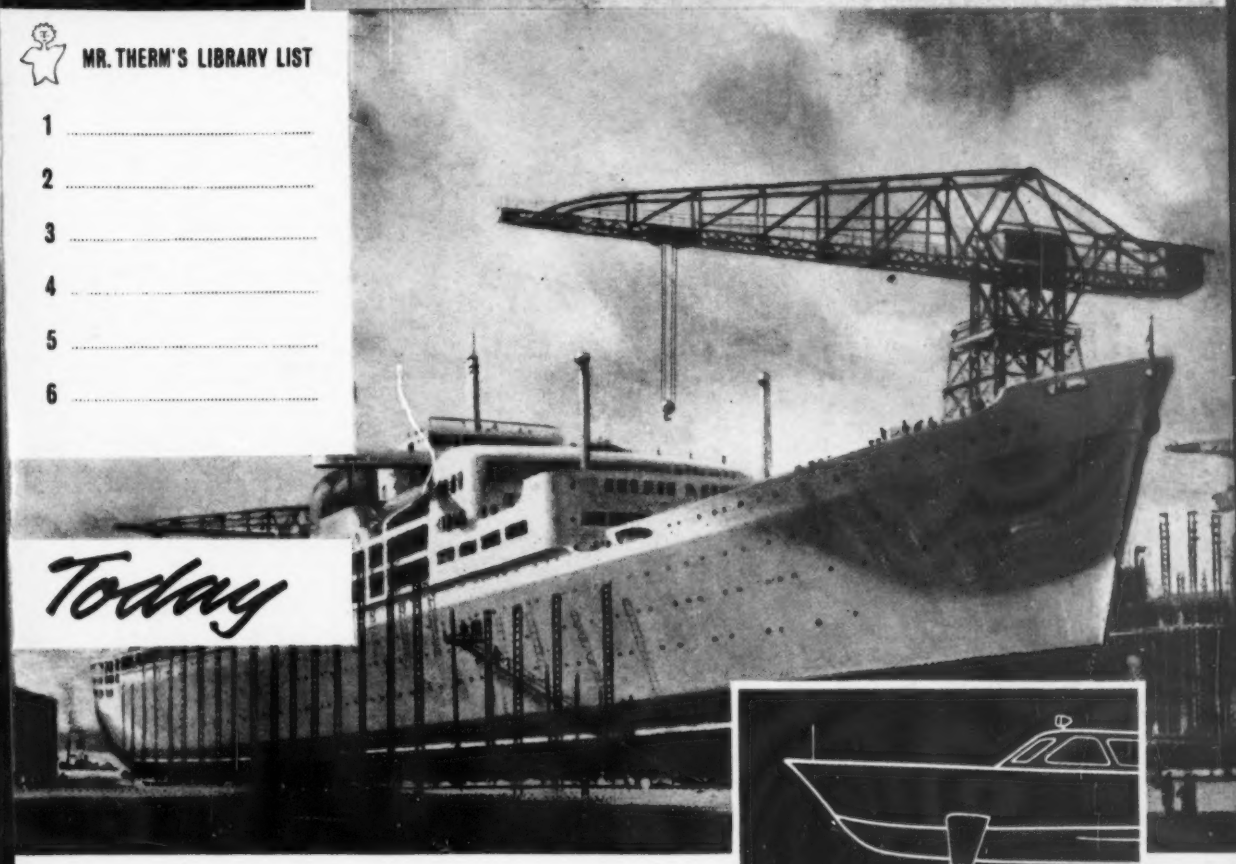

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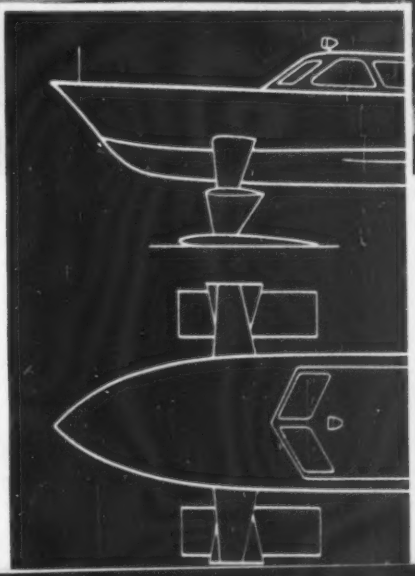

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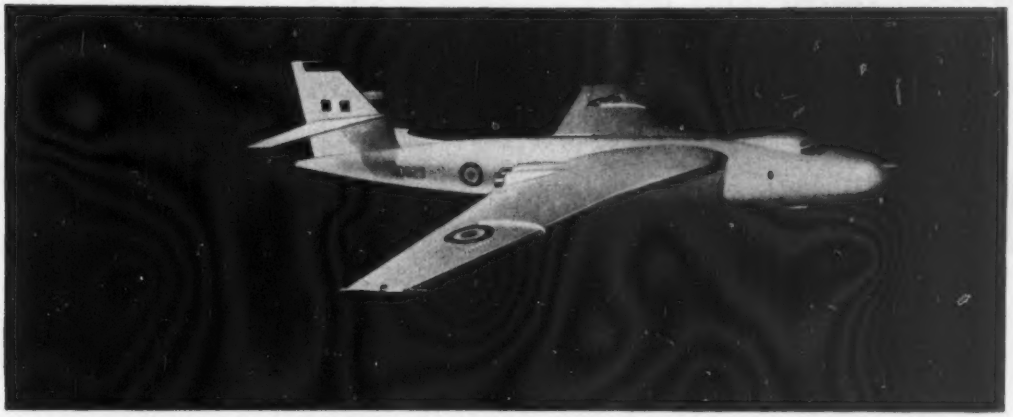

The Vickers 'Valiant' bomber owes some part of its tremendous speed to the glass-smooth paint surfaces.

The Valiant flies a little faster— thanks to ATLAS COPCO

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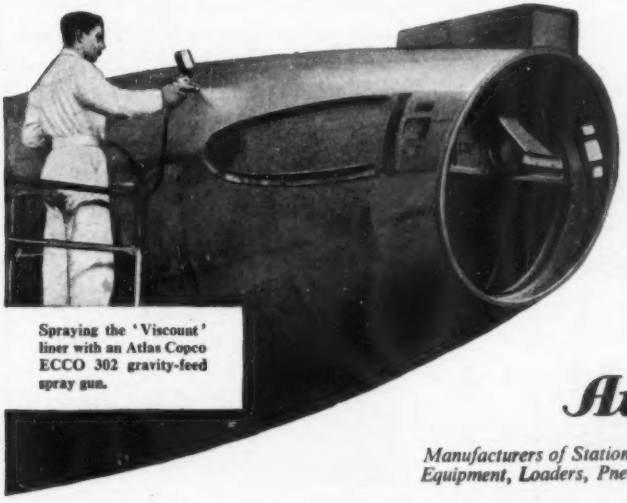

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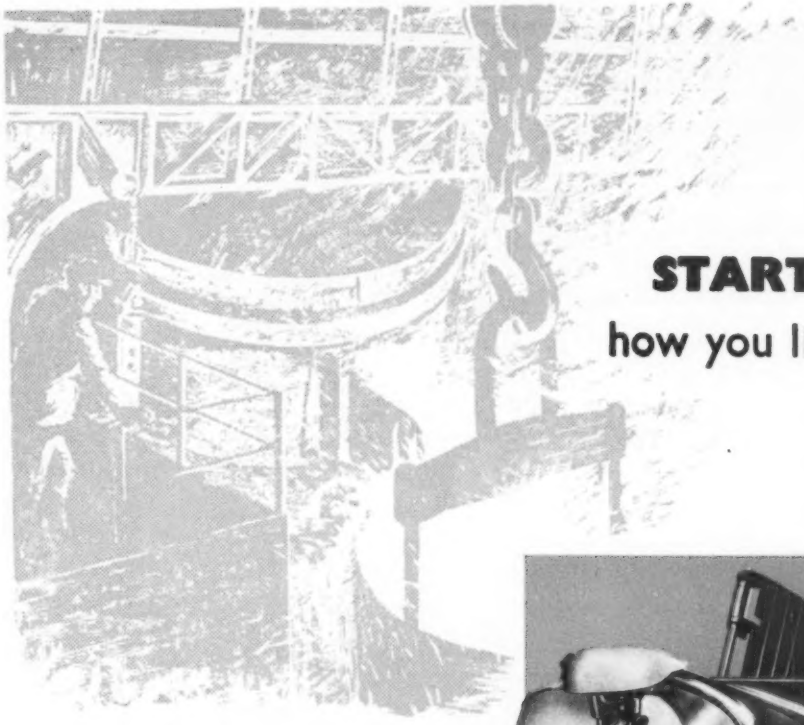

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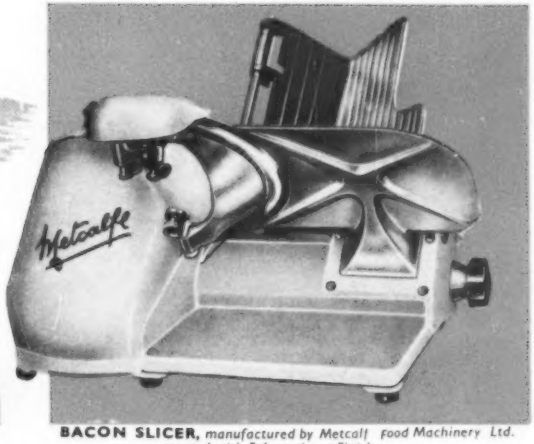

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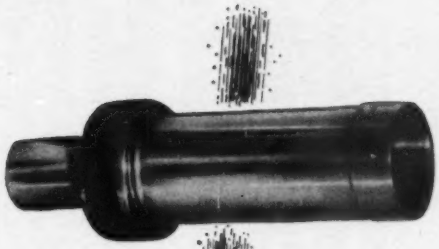

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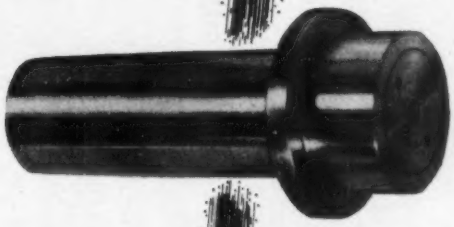

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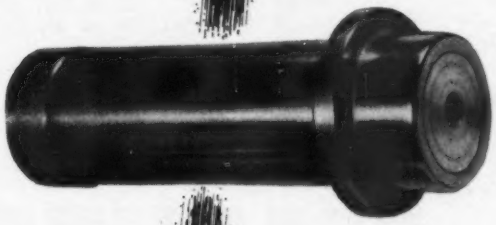

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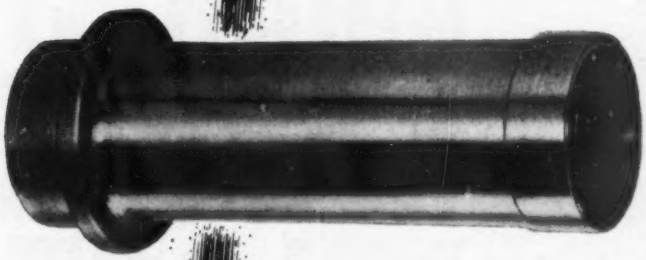

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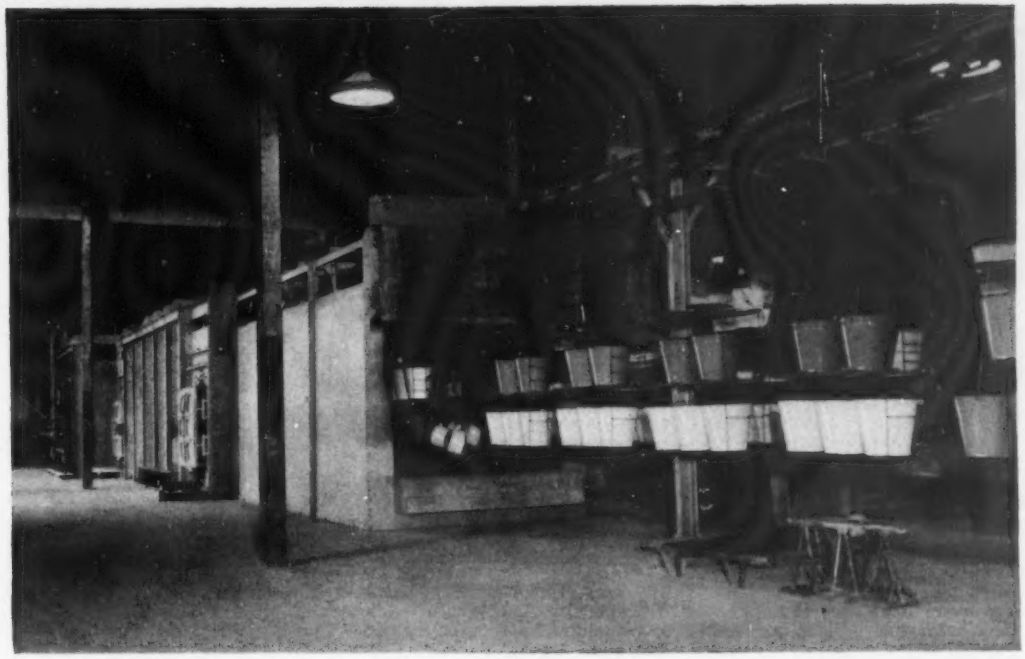
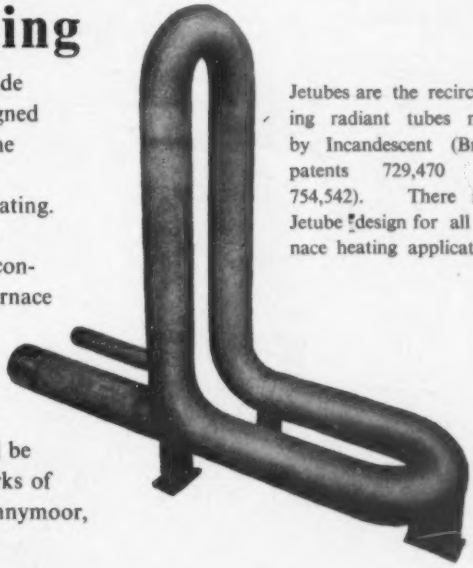


Latest in enamelling

All other heating methods look archaic beside the new Incandescent L-shaped Jetubes. Designed specifically for fusing furnaces, this form of the Jetube has a large radiating surface and low thermal storage, giving fast and flexible heating. Installation costs are low, and the system is equally revolutionary in batch and continuous furnaces. The first batch furnace using this system will be in service in a few weeks, followed by a continuous furnace, similar to that illustrated above, also heated by Jetubes which will be installed at the Tricity works of Smart & Brown Ltd., Spennymoor, Co. Durham.



Jetubes are the recirculating radiant tubes made by Incandescent (British patents 729,470 and 754,542). There is a Jetube design for all furnace heating applications.

INCANDESCENT *COATINGS DIVISION*

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Fuel Selection for Annealing Castings

"replacing an existing furnace by one using town gas due to the high maintenance and replacement costs incurred with existing equipment".

Langley Alloys Ltd., manufacturers of the well-known "Langalloy" and "Hidurax" alloys, face a problem common to most heat treatment process users in that they need a flexible plant to treat loads varying in size and metallic composition.

For example, a recently installed furnace at Langley Alloys Ltd. is used primarily for the heat treatment of corrosion resistant castings in the "Langalloy" series of nickel-based and stainless steel alloys, yet it had to be satisfactory for hardening and tempering large forgings in aluminium, bronze and other copper-based alloys.

The nickel-based alloy castings include nickel-molybdenum-iron and nickel-chrome-molybdenum alloys which are solution heat treated by holding them at temperatures ranging from 1,150°C to 1,250°C followed by a water quench or air blast. This treatment ensures maximum corrosion resistance and eases the machineability.

Stainless steel castings include chromium steels and various grades of chromium-nickel austenitic steels, and the heat treatment is carried out at 950°C to 1,100°C, after which they are water quenched.

THE PROBLEM

The North Thames Gas Board Industrial Department was asked to collaborate in replacing an existing furnace by one using town gas due to the high maintenance and replacement costs incurred with the existing equipment. It was pointed out that the furnace hearth was subjected to hard wear caused by heavy parts being dropped on to it during loading. A bogie hearth furnace was suggested measuring 4 ft .0 in. long by 3 ft. 0 in. wide. After the bogie hearth was withdrawn it had to be capable of being tilted so that the articles could be tipped into a side quenching tank. A maximum temperature of 1,250°C held within ±10°C was also stipulated.

A further requirement was a steel table used as a loading platform at the same height as the bogie hearth with a quenching tank sunk into the floor.

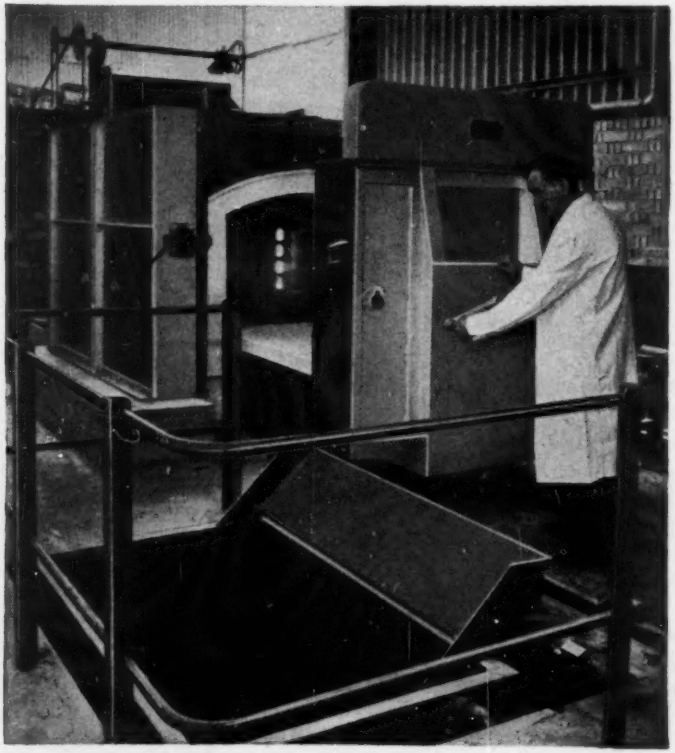

Fig. 1

A front view of the gas-heated annealing furnace at Langley Alloys Ltd. showing the furnace construction and the hearth part withdrawn towards a sunken quench tank.

THE EQUIPMENT

The North Thames Gas Board discussed the requirement with the furnace manufacturers, and eventually a furnace was supplied and fitted to the following specification:

Dimensions of Furnace—Door opening 3 ft. 6 in. wide and 1 ft. 11 in. high from the top of the bogie to the spring of the door arch. Length from door face to back wall of 4 ft. 10½ in.

Wall and Arch Construction—Lightweight insulating refractory backed with diatomaceous insulation.

Casing—Totally enclosing the brickwork except the roof. Adequate in strength to prevent any distortion. Finished in heat resisting aluminium paint.

Bogie Construction—High quality firebrick top backed with insulating refractory. Door forming back of the bogie lined with lightweight insulating refractory and diatomaceous material. Sandseals on the sides and end of the car to prevent hot gases escaping from the furnace chamber. Wheel axles in roller bearings for

easy bogie movement. Hand wheel operated clamping screws on door to lock the bogie in position—the door protecting the operator against radiation as the bogie is withdrawn. Manual withdrawal by a chain and bevel gear drive to the wheels with operating handle at a convenient height on the back of the door. Sufficient rail length for withdrawal of the bogie clear of the mouth of the furnace for loading and unloading.

Gas Burner Equipment—Two air blast burner blocks firing from the rear wall on each side of the furnace. No flame impingement on the charge—the hot gases, after passing to the door, are drawn back through flues in the rear wall arranged at bogie hearth level. Flues connected to a common outlet with damper control.

Each burner set provided with graduated air and gas control cocks. A motorized valve, wired through a temperature control panel, simultaneously operates valves in the main air and gas supplies according to the heat input requirements.

Other controls on the main gas supply include a constant pressure governor, non-return valve and a solenoid operated main shut-off valve.

Air Supply—Fan blower at 22 in. w.g.

Loading Equipment—Mild steel loading table is provided with a top for easy loading of the work on to the bogie. As the hearth is at temperature all loading is carried out with tongs.

Unloading—A hand operated tilting device, the door again shielding the operator from the high temperature during bogie tilting. Locking device provided holding the bogie to the rails during this operation.

Quench Tank –Mild steel plates suitably braced. 3 ft. 0 in. wide by 4 ft. 6 in. deep by 5 ft. 0 in. long to quench 500 lb of castings with a water temperature rise to 140°F.

Safety Control—Diaphragm switches in both air and gas lines connected to solenoid valve in the main gas line. The solenoid valve closes with failure of gas or air supply and cannot be opened until it has been manually reset.

Test Results—Tests were made during a day's operation to determine the performance of the furnace under normal operating conditions. The working temperature of 1,050°C was obtained in 1¾ hours after lighting from cold for a gas consumption of approximately 12½ therms. The time to recover working temperature following loading was between a quarter and half an hour, depending upon the size of the charge.

One charge consisted of 291 lb of small castings of nickel based stainless steel, and the working temperature was recovered in 20 minutes for a consumption of 2½ therms of gas. A further 4 therms were consumed whilst one hour's soaking was taking place, giving a total of 6½ therms for the treatment of the charge.

It is estimated that to heat the furnace and a 500 lb charge to 1,250°C would take 3 hours and require approximately 25½ therms of gas. For a follow-on charge of 500 lb, assuming the furnace to be at 1,350°C and the bogie at 1,000°C, would take 1 hour with a gas consumption of 11½ therms.

. . .

Langley Alloys Limited also use town gas in their foundry for shell moulding, core drying, ladle drying and other specialised foundry requirements as well as for canteen and welfare purposes.

This is one example of collaboration between the user and plant supplier where the North Thames Gas Board offered a free consulting service. An Industrial Gas Officer at any Area Gas Board can avail himself of the experience of his colleagues in other Gas Boards through the medium of the Gas Council's Industrial Gas Development Committee. And, of course, heat treatment is but one of the many trades, professions and occupations using the facilities and research of the British Gas Industry.

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The Gas Council, 1 Grosvenor Place, London, S.W.1

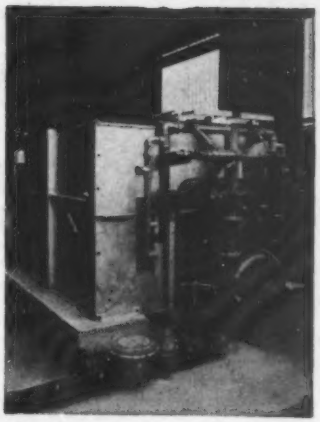
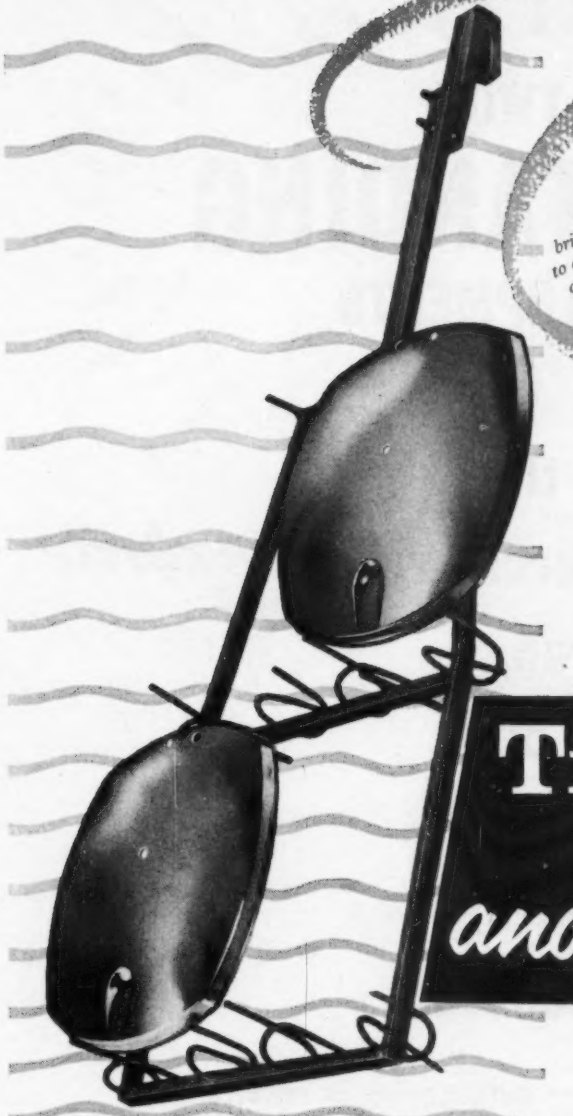


Fig. 2

A rear view of the annealing furnace showing the gas/air controls and safety devices.

Fig. 3

A view showing the hearth completely withdrawn—the door protecting the operator from radiation from the charge—and being tilted towards the quenching tank



I.C.I. Titanium rack used by Hoover (Washing Machines) Ltd. for processing components through chemical brightening and anodising solutions. Experience to date indicates a maintenance-free service life of at least 2 years (2,500 cycles), compared with an average life of less than 3 weeks for racks in conventional materials.

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TM39

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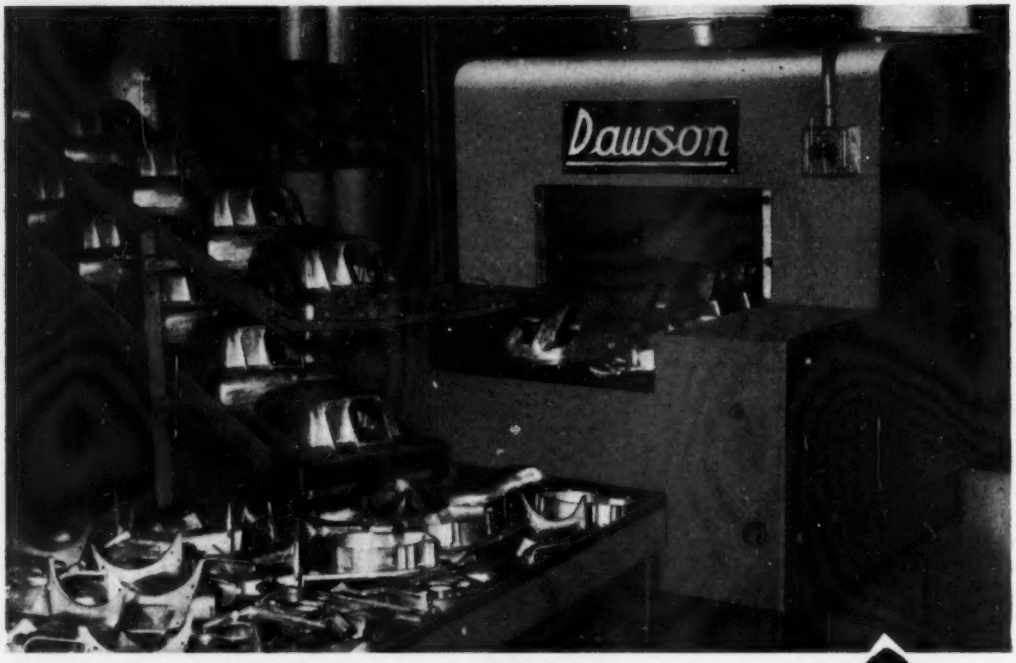
THIS JOURNAL IS DEVOTED TO THE SCIENCE AND TECHNOLOGY OF PAINT APPLICATION, ELECTRODEPOSITION, VITREOUS ENAMELLING, GALVANIZING, ANODIZING, METAL SPRAYING & ALL METAL FINISHING PROCESSES. THE EDITOR IS PREPARED TO CONSIDER FOR PUBLICATION ANY ARTICLE COMING WITHIN THE PURVIEW OF "METAL FINISHING JOURNAL" AND ALL SUCH ARTICLES ACCEPTED WILL BE PAID FOR AT THE USUAL RATES.

Contents

Cleaning component parts for the new Hoover Junior Cleaner



At the highly mechanised Hoover Factory at Perivale in Middlesex a Dawson metal cleaning and degreasing machine plays an important role in the efficient production line for the new Hoover Junior cleaner. The illustration above shows how the three diecast components converge ready for washing. The two smaller components come from the bottom left and the housing comes down the chute from the top left.

This is only one of the countless applications for the Dawson metal cleaning and de-greasing machines which are widely used in every grade of engineering from electric shaver components to heavy diesel cylinder blocks.

A catalogue giving full details of these machines can be sent, on application, from Drummond-Asquith (Sales) Limited at the address given below.

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FRONTIER TROUBLES

FRONTIERS are seldom out of the news. Their very nature and the fact of their existence as a line of demarkation between two contrasting and often antagonistic entities singles them out as areas of potential conflict. While this is a sad but true commentary on the state of human affairs it can be applied with no less justification in a less animate context. The juxtaposition of two differing materials can set in train a sequence of events and effects, many of which may be undesirable, or which, in some cases, may be deliberately sought to achieve a desired end.

As a simple example of undesirable effects resulting from contact between two otherwise blameless materials can be cited the use of copper fastenings on aluminium components. While either metal used alone exhibits a very effective degree of corrosion resistance when used in conjunction the area of contact immediately becomes susceptible to very rapid disintegregation. The forces which bring this about, although disastrous in this particular set of circumstances, can on the other hand be harnessed for beneficial purposes in such applications as cathodic protection and galvanized coatings.

It is in this Tom Tiddler's ground that lies between substrate and coating, where powerful forces are at work whose activities are only lately coming to be recognized, that the greatest amount of research into metal finishing processes still remains to be done. It is in the interaction of basis metal and coating, whether it be paint, electroplate, vitreous enamel, anodic film or hot-dipped, that the success or early failure of a finishing process lies.

As Professor A. I. Andrews points out in the course of the first Mellor Memorial Lecture, presented at the Silver Jubilee Conference of the Institute of Vitreous Enamellers and reproduced elsewhere in this issue, the theories which have been devised to explain the mechanism of adhesion of vitreous enamel to steel are numerous and conflicting and each has attracted its own body of supporters. Any one of them may in fact be correct, but to date such work as has been carried out has failed to establish any real priority of authenticity.

A similar state of indeterminacy exists with regard to what takes place at the interface between the basis metal and the plated coating, or even a paint film and the surface to which it is applied, although there is evidence of some careful work being carried out in this field. An interface is, almost by definition, an area which does not lend itself very readily to study, and attempts to do so often disrupt the pattern of normal behaviour in the same way that the sending of commissions of enquiry into troubled frontier zones can have a temporarily inhibitory effect on the trouble makers.

Not only does the adhesion, and consequently in large measure the service performance of a coating, depend on conditions obtaining at the interface, but as has been shown in certain specialized applications, the surface condition of the substrate can modify to a very significant extent some mechanical and physical properties of an electrodeposited coating. Use has been made of this fact in the development of a technique for producing sheet nickel, whose ductility, hardness and abrasion resistance appear to be superior to that obtainable by any other procedure.

In the specification of an attractive and acceptable coating such outward attributes as colour, gloss and resistance to corrosion have an obvious market value, but their entire worth is offset if the coating which exhibits them fails to adhere satisfactorily to the metal which it is designed to decorate and protect. The activities, whether subversive or otherwise, of agents in the frontier region must repay yet closer study.

Talking Points

by "PLATELAYER"

TOPICAL COMMENT FROM THE MAIN LINES AND SIDE LINES OF METAL FINISHING

INDUSTRIAL TOTALISATORS

IT is an interesting observation that most of us enjoy pulling levers and operating mechanical gadgets, as any visitor to a fun fair soon discovers! Yet the problem of boredom in modern factories where the same kind of thing is done by workers for a living is giving some industrial psychologists much concern. It has, therefore, been suggested that the introduction of a play element into work of this kind might be helpful in maintaining interest.

The idea is not so absurd as may at first sight appear. For example, it is quite common to have an incentive bonus scheme in operation in many factories, the rewards being calculated each week. How much better it would be, however, if, say, a plating tank were equipped with a dial device recording each rack load of work as it was introduced, moving against a clock hand. If the operator's score beat the clock by fully loading the tank ahead of the scheduled time, he would get the jackpot in the form of a coin ejected by the mechanism, as in a "fruit machine." How much more encouraging to effort this would be than a typewritten slip giving a record of bonus earnings a week before !

There seems to be no end to the intriguing possibilities. Automatically computed earnings figures flashed onto a screen continuously in front of each worker as he does his job would really make things hum, especially if his colleague's achievements were simultaneously projected. A world of sporting competition is brought up besides which the results of the Saturday football match pales into insignificance.

IS CHROME FINISHING UNDESIRABLE

AN interesting observation in a recent American survey of corrosion results on copper-nickel-chromium coatings is that colour buffing of chromium plate reduces its protective value, but that this can be substantially offset by re-immersion of the work in chromium plating solution. This is different from the effect on nickel and copper coatings, which tend to be improved by light buffing. Normally, if plating conditions are right, buffing of chromium is not necessary, but for a high standard of finish it is still often carried out.

Various attempts have been made to find an after-treatment for chromium plate which will have an inhibiting influence and improve the durability of the deposit. One or two have been shown to be promising, but they often do not survive cleaning and polishing. This is an instance where exposure testing can give misleading results as such samples are not generally subjected to periodic cleaning as are plated articles in actual service.

AIMO

TAKING the skill out of a production operation is a major aim of industrial management nowadays. The object is to eliminate the " human element " either by mechanisation or simplification. The newest development in this direction is designed to obviate even the need for being able to read. Audio Instructed Manufacturing Operation, as it is called, replaces the normal instructions given by means of a document or even by a blue print, by a tiny radio receiver worn by the worker. The instructions are picked up from a tape recorder, so that the operator can listen to each set of instructions as he needs them. The possibilities are especially great in countries where immigrant or illiterate workers are involved, since the instructions can be provided in any language.

The implications of the system are tremendous. Should the instructions be given in a sergeant-major manner, or in a gently requesting voice? Or, possibly, if the words were recorded as a calypso and sung, greater outputs might be achieved. The industrial psychologists are going to have a rare time if the system spreads.

THE LECTURE SEASON OPENS

"FROM my own experience, a lecture is often a very dangerous method of teaching ; it is apt to engender in the mind of men ungrounded conceit and sciolism, or the bad habit of knowing about subjects without really knowing the subject itself. A young man hears an interesting lecture, and carries away from it doubtless a great many new facts and results ; but he really must not go home fancying himself a much wiser man ; and why ? Because he has only heard the lecturer's side of the story. He has been forced to take the facts and results on trust . . .

Of course, where the lecture is a scientific one, illustrated by diagrams, this defect is not so extreme: but still the lecturer who shows you experiments is forced to choose those which shall be startling and amusing rather than important and after all an experiment is worth very little to you, unless you perform it yourself, ask questions about it, or vary it a little to solve difficulties which arise in your own mind." *Charles Kingsley* (1846).

THE INSTITUTE OF VITREOUS ENAMELLERS

Silver Jubilee Conference and Exhibition

London, September 14-18, 1959

THE Twenty Fifth Annual General Meeting in association with the Silver Jubilee Conference of the Institute of Vitreous Enamellers was held at the Park Lane Hotel, London on September 17, 1959, with Mr. J. H. Gray, chairman of Council, presiding. Supporting him on the platform were Mr. W. T. Wren, president of the Institute, and Mr. W. S. Grainger, hon. treasurer.

Opening the proceedings, the chairman extended a cordial welcome to all members and visitors who were present, particularly those from other countries, and referred specially to the presence of Professor A. I. Andrews of the Department of Ceramics, University of Illinois, U.S.A., who had been invited to deliver the first Mellor Memorial Lecture.

Following the formal approval of the Minutes of the previous Annual General Meeting, Mr. Gray presented his report on the activities of the Institute and its Committees during the fifteen months since he had last addressed the meeting. One of the principal concerns of the Council was to maintain a steady rate of membership recruitment and he was glad that membership of the Institute continued to grow. With the passing years numbers of younger men were entering the industry and it was important that the advantages of membership of the Institute should be brought to their notice.

As a technical body the Institute carried out most of its more important work through the medium of its Technical Committee and its various sub-committees which, under the chairmanship of Mr. J. W. Gardom, had been successful in bringing a number of investigational projects to completion with the result that at least one sub-committee final report was to be discussed during the ensuing technical sessions. Other reports had been, or would be, published and new research projects had recently been taken in hand.

Responsibility for arranging the technical programme of the Annual Conference lay with the Literary and Awards Committee, with Mr. J. Hooper as chairman, and Mr. Gray stressed the desirability of members who wished to present communications to the Institute informing the Secretary, or Mr. Hooper to this effect at the earliest possible date. The Committee also made recommendations to Council in connexion with the various Institute awards, and it gave him very great pleasure to be able to announce that during this Silver Jubilee year there was to be a presentation of the Biddulph Award for the first time. The Development and Publications Committee, also under the chairmanship of Mr. J. Hooper, was charged with the responsibility of recommending to Council ways of increasing the usefulness of the Institute to its members and of attracting an even wider membership. This Committee had recently submitted a report on the possibility of increasing the direct technical service which the Institute could make available to members and an investigation of the possibilities was in train.

The Education Committee, of which Mr. Gray was himself chairman, still had as its main interest the Annual Enamelling School, the next of which would be held in Buxton early in October. Mr. Gray urged that every facility and encouragement should be given to junior staff to attend this school, whose value had been incontrovertibly established in previous years.

Mr. Gray said that he was pleased to be able to report continued progress of the International Enamellers Institute which had been set up in the previous year, largely on the initiative of the Institute of Vitreous Enamellers and of which he had been elected first chairman. He had been succeeded in this office for the coming year by Mr. Kuppersbush, chairman of the German Enamelling Institute, and serious attention was being paid to the possibility of reaching international agreement on terminology and methods of testing in relation to enamels.

The chairman concluded his report by expressing appreciation of the work of the Secretary over the past year, and of the contributions made by all who served the Institute in an honorary capacity. He also referred to the regretted death of Dr. J. Hurst, past president of the Institute, which had robbed the Institute of a personality whose en-

thusiastic support and guidance had been unfailingly available.

Following the chairman's report, the annual accounts which showed a small excess of expenditure over income for the year, were presented by the hon. treasurer, Mr. W. S. Grainger, and unanimously adopted.

The chairman then called on Mr. J. W. Gardom, as senior past president representing the committee of past presidents, to speak on the nomination of a president-elect. Mr. Gardom said that on this occasion, the Silver Jubilee Year of the Institute, the committee had, after very careful thought, decided to make a departure from their normal approach to the selection of a nominee for the office of President of the Institute. In previous years they had sought to enlist the interest of a person of industrial or academic eminence, who might be indirectly associated, although not directly concerned with the vitreous enamelling industry. In this Jubilee Year however, it had been thought proper to recognise the enthusiastic and honorary services which had been rendered to the Institute since its inception by Mr. W. S. Grainger, and it therefore gave him great pleasure to put the name of Mr. Grainger before the meeting for adoption as President-elect for the coming year. Mr. Grainger's nomination was supported with acclamation by the meeting.

The formal business of the meeting concluded with the announcement of the election of three members of Council. In the absence of other nominations the three retiring members, Mr. J. H. Gray, Mr. N. S. C. Millar and Mr. J. Nicholls, were declared re-elected.

Presentation of Awards

Of the three awards which lie within the gift of the Institute, recommendations had been accepted by Council for the presentation of two. The W. S. Grainger Medal was awarded to Mr. J. W. Pedder. In making the presentation, Mr. W. S. Grainger, who had endowed the medal, said that it was awarded annually in recognition of significant contributions in technical or other fields to the work of the Institute. He was sure that all present would be aware of the constant

Mr. W. T. Wren, president of the Institute of Vitreous Enamellers (right) and Mrs. Wren, with Mr. J. H. Gray, chairman of council and Mrs. Gray prepared to receive guests at the Silver Jubilee Banquet

interest and support afforded to the Institute by Mr. Pedder, and many of them had been privileged to hear his paper on the wear-resistant properties of enamel coatings which had been presented at the Annual Conference in the previous year.

The second award made on this occasion was the Biddulph Medal, and this also was presented by its donor, Mr. A. Biddulph. Mr. Biddulph said that it gave him particular pleasure to be able to present this medal at this time, because there had for some years been a lack of contestants for it. As originally conceived, it had been regarded as a supplement to the Whittle Medal, intended for the particular encouragement of workshop personnel. With the falling off in entries for the Whittle Medal it had been decided to make some change in the method of its award, and in consequence it had been offered in the previous year to the member who submitted the best critical commentary on the Institute's Annual School. This had evoked a lively response, and Mr. Biddulph said that it gave him great pleasure to present the medal to Mr. R. C. Benson, and to congratulate him on the standard of his contribution.

Annual Conference and Exhibition

The actual business of the Silver Jubilee Conference had commenced three days prior to the Annual General Meeting, on Monday, September 14, when the official opening of the Exhibition had been followed by a reception to conference delegates by the president and chairman of Council of the Institute with their ladies. The following day was entirely devoted to a series of works visits in the London area, the works visited being : Belling and Co. Ltd., Benjamin Electric Ltd., Lafarge Aluminous Cement Co. Ltd., and R. and A. Main Ltd. The evening provided the opportunity for an informal conversazione. Further visits were made on the following day to the works of Aladdin Industries Ltd., British Bath Co. Ltd., Frigidaire Division of General Motors Ltd., and The General Electric Co. Ltd., followed in the evening by a dinner-dance and cabaret in Quaglino's ballroom.

Mellor Memorial Lecture

Following the Annual General Meeting, the President, Mr. W. T. Wren, took the chair to preside over another technical landmark in the history of the Institute. To mark the twenty-five year anniversary, Council had decided to inaugurate a Medal Lecture to be delivered at intervals of two or more years by some person of technical eminence in the broad field of ceramics and allied technologies. This lecture would commemorate the work of Dr. J. W. Mellor, the first president of the Institute of Vitreous Enamellers and an outstanding name in ceramic science. The invitation to be the first Mellor Memorial Lecturer had been extended to Professor A. I. Andrews, Professor of Ceramic Engineering at the University of Illinois, who had achieved world renown for his work and writings on the subject of ceramics in general, and vitreous enamel in particular.

In introducing Professor Andrews, the president said that the meeting welcomed him, not only as a distinguished scientist, but also as a citizen of the United States and official bearer of greetings from the American Ceramic Society to the Institute on the attainment of its Jubilee Year. After thanking the president and the meeting for the cordiality of their welcome, Professor Andrews delivered the first Mellor Memorial Lecture, the text of which is published elsewhere in this issue.

" Vitreous Enamel Today "

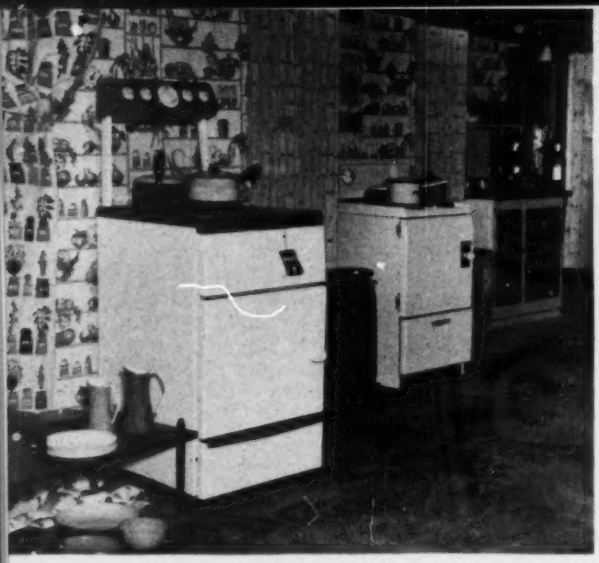
As an adjunct to the Silver Jubilee Conference, the Institute staged an exhibition in the Park Lane Hotel adjoining the venue of the technical sessions. The Exhibition was grouped into three sections : The first of these provided an opportunity for the suppliers of materials and equipment for the enamelling industry to exhibit their products.

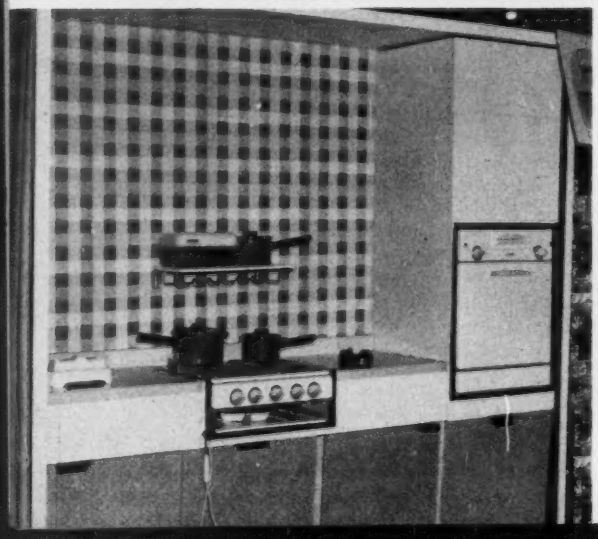
In this section the Aerograph De Vilbiss Co. Ltd., displayed a selection of spray guns for applying vitreous and ceramic coatings. The guns are designed to resist the excessive wear from the enamel passing through at high velocity. " Nitralloy " fluid tips and needles are normally used for vitreous materials while stainless steel liners are fitted to the fluid passages of the gun.

Blythe Colour Works Ltd., showed the very wide range of pigments for vitreous enamels and ceramic glazes, and a range of aluminium enamels that are leadless, weather resisting, non-crazing, non-chipping, and flexible.

Borax and Chemicals Ltd., exhibited the Three Elephants brand of boron products, including Pyrobor (anhydrous borax), V-BO 9 (refined pentahydrate borax), borax decahydrate and boric acid. Backcloth of the stand was a photograph of the plant of the American Potash and Chemical Corporation (the parent company) at Trona, California, where borax and a wide variety of other chemicals are extracted from the brines of Searless Lake. Also included in the display were the " Bikita " range of minerals mined by Bikita Minerals Ltd., in Southern Rhodesia, and the rare earth chemicals produced by the Lindsay division of American Potash and Chemical Corporation in the United States. Borax and Chemicals Ltd., are selling agents in the U.K. for all these products.

Laporte Titanium Ltd., showed the range of titanium oxide grades introduced at the end of last year. The products have free flowing, easy





mixing, and readily soluble properties, and the exhibits on view included demonstration panels illustrating the colour tones obtained in a variety of types of white enamels.

Exhibits by Mill Room Accessories and Chemicals Ltd., included steatite bricks and grinding balls, and heat-resisting perritts and furnace hooks. A pot mill shown had a closure said to be a marked improvement on the older type with the ground-in lid. Perritt equipment included hanging frames, clip-on spikes and tubular sections. Luminous enamel for advertising and road signs was also featured.

Sismey and Linforth Ltd., had on show the range of box and continuous enamelling muffles and static rotary enamel smelters which they design and make. The gas-fired muffles incorporate ceramic refractory tube recuperators, and the oil-fired muffles have waste heat recovery apparatus to provide hot air both for oil atomization and for delivery to driers. The smelters are fitted with heat-resisting steel recuperators, reducing fuel consumption by a considerable amount.

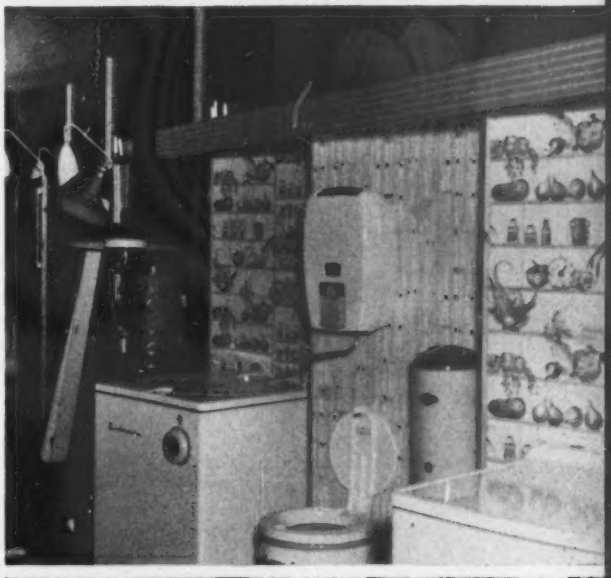
Staveley Iron and Chemical Co. Ltd. featured a new addition Orthsil F7, to their standard Orthsil F and F2 alkaline cleaners, developed for the removal of oil from slightly rusty components.

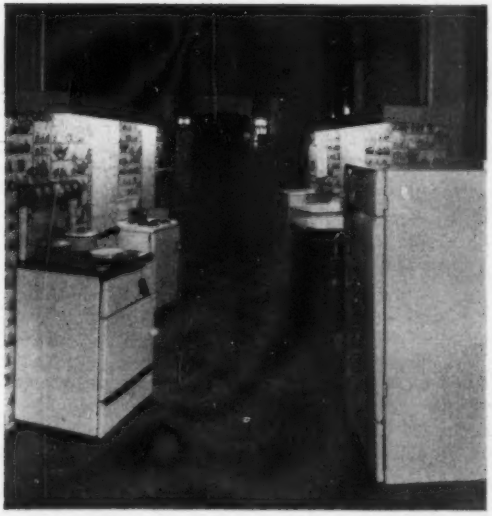
The illustrations on this and the facing page show aspects of the section of the exhibition on the theme "Vitreous Enamel To-day" staged by the Institute of Vitreous Enamellers as a feature of their Silver Jubilee conference in collaboration with the Vitreous Enamel Development Council.

In addition to doing this work, it is only slightly slower in removing drawing compounds from bright plate than the F2. Claimed to be free from any trouble that might be caused by using hard water, the equipment should be of particular benefit to jobbing enamellers and others using pressings that have been stored for some time before processing.

On the Stordy Engineering Ltd., stand was the range of Hauck oil burners. The burner can employ fuel having a wide range of viscosities (if appropriately heated) and will proportion all primary and secondary air-flow automatically and accurately with the oil flow. A single lever control can be employed to maintain a pre-set air-oil ratio from minimum to maximum capacity. Fuel consumption can thus be considerably reduced.

Tilghman's Ltd., had on view two working models of the shotblast equipment they supply to the vitreous enamel trade. The equipment is used both for preparing the metal surface for the subsequent enamelling, and for stripping enamel from rejected work. One of the models was an overhead conveyor type machine on which baths are loaded and progressed through the plant on three or four lengths of conveyor. The baths pass in front of the shot firing wheels on each conveyor run. The other model comprised a rotary table plant designed for cleaning flat surfaces, such as cooker parts, etc. Experiments are at present being carried out by the company on the shot-blasting of steel parts as a preliminary to enamelling with results which so far appear encouraging.





The second and largest section of the Exhibition was staged, under the generic title "Vitreous Enamel Today," in collaboration with the Vitreous Enamel Development Council. The aim of this section, which was very effectively achieved, was to demonstrate the wide range of domestic and industrial applications of enamel and it included a large number of exhibits contributed by company members of the Institute.

On the domestic side were an impressive bathroom unit in primrose yellow, a number of solid fuel stoves and boilers, refrigerators, washing machines, a dishwasher, and many items of hollow-ware. It was perhaps among the hollow-ware exhibits that the introduction of bright colours and modern designs was most noticeable and an interesting development, which was apparent, was the large proportion of enamelled cast iron hollow-ware which was on view.

The industrial exhibits highlighted the use of enamel in the aircraft, atomic energy and structural industries where its heat and weather resisting and dielectric properties are effectively exploited.

In aero engines special heat resisting enamels have been used to prevent the intergranular corrosion that can affect such parts as exhaust manifolds at high temperatures and, in many cases, these coatings have increased the life of such components between four and five times. In these cases the enamel is normally applied to a stainless steel base, but a new and interesting development on show was a rocket exhaust nozzle forged in aluminium and finished internally with vitreous enamel, an admirable testimony to the re-fractoriness of the coating.

Use of enamel as a weather resistant coating was demonstrated by two particularly contrasting examples — a coat of arms for Martin's Bank and a gruesome representation of Chinese peasants being mown down by a vast steam locomotive. Produced in 1926 this latter was intended to warn in graphic style illiterate Chinese country dwellers of the dangers of tresspassing on the permanent way of Chinese State Railways.

It is only in very recent years that there have been available in this country, or indeed anywhere else, enamel frits suitable for application to aluminium and its alloys. Of considerable topical interest therefore, was a display of coloured enamelled aluminium panels for use in building where to the non-fading, non-weathering properties of the enamel is added freedom from corrosion at areas of accidental coating rupture.

Some impression of the scope of this section of the Exhibition can be gained from the photographs in these pages and it is impossible to refer to the exhibits in more than general terms. The general impression created however, was that enamel is a finish with many unique and inimitable virtues and the industry remains very much alive to its potentialities.

In marked contrast to the dazzling and hygenic whites of the domestic exhibits and the gay colours of the hollow-ware, were the exhibits in the third section of the Exhibition devoted to examples of enamelling from the past. Here were vases and plaques, teacups and saskets, mostly dating from the late nineteenth and early twentieth century, but all conveying a sense of great antiquity as is proper in an art which was old when Julius Caesar came to Britain.

Silver Jubilee Banquet

The Conference culiminated on the final evening with the Silver Jubilee Banquet held in the Ballroom of the Park Lane Hotel, where the President entertained at the top table a gathering of eminent personalities representing kindred organisations headed by the principal guest The Rt. Hon. The Earl of Verulam. Lord Verulam proposed the toast of the Institute and the Industry in highly unconventional style which earned rapturous acclaim from the three hundred assembled members and guests. Mr. W. T. Wren, responded as President of the Institute, and Mr. H. E. Wincott, replied on behalf of the guests to the toast proposed by Mr. J. H. Gray, Chairman of Council. The formal proceedings were followed by dancing into the early hours.

Below and in the pages which follow we present short abstracts of the technical papers presented at the first technical session, together with a preliminary report of the discussion which followed their presentation. The full text of the papers and the authoritative version of the discussion will be published in due course by the Institute of Vitreous Enamellers.

Abstract No. 1

THE INFLUENCE OF HYDROGEN IN THE VITREOUS ENAMELLING OF STEEL.

*by Gordon P. K. Chu**

GASES evolved during enamelling can be traced to the following principal sources.

1. From the frit itself.
2. From the milled slip.
3. From the basis metal.
4. From the furnace atmosphere.
5. From a reaction involving some combination of these sources.

It has been found that the main constituents of the gases evolved are : H_2O, CO and CO_2, while the content of N_2 and hydrocarbon gases is negligible.

*Manager, Basic Research Dept., Pfaudler Co.

Defects produced by gas evolution fall into two categories :

1. Room temperature or delayed defects, e.g. fish scales, shiners, bloats popoffs, jumpers, etc. These have been shown to be definitely associated with hydrogen and may occur immediately after firing or after intervals of up to several months.

2. High temperature defects, e.g. blisters, pinholes, pits, blackspecks etc. which are caused by the evolution of oxides of carbon as well as hydrogen. These are formed during firing when the coating is fluid. Ground coat reboiling blisters are directly caused by hydrogen.

The paper goes on to examine in detail the relative significance of each of the potential sources of hydrogen and also the behaviour of such hydrogen during the enamelling process. The points made are summarized as follows :

1. A high initial content of hydrogen in steel will cause serious fish scaling.

2. Water and OH ions in glass structure are important source of hydrogen enamel frit smelted in " wet " atmosphere contains more structural components of OH groups than those smelted electrically, as indicated by infra-red transmission measurement.

3. Combined water in enamelling clays is another serious source of hydrogen defects. The quantity and temperature range at which the structural water dissociates are the chief factors to consider. Clays liberating less combined water at lower temperatures are more favourable for enamelling.

4. Moisture in furnace atmosphere is extremely influential to the quality of enamelled products. Enamel defects increase with the increasing amount of moisture content. When the dew point of the furnace atmosphere is higher than 8°C. the susceptibility to fishscaling will be greatly enhanced. Fishscaling and reboiling may be greatly decreased or completely avoided by firing in dry atmosphere.

5. Behaviour of hydrogen in various enamelling steels and alloys is evaluated by cathodic charging of the hydrogen steels (such as titanium bearing steel) having a higher occlusion capacity for hydrogen are less or non-susceptible to fish-scaling and re-boiling.

6. Reboiling blisters are formed by the sudden release of hydrogen from the diffusible hydrogen in the steel. Hydrogen gas responsible for fishscaling can be manifested in the form of reboiling blisters. Fishscaling and reboiling are both derived from the evolution of hydrogen, but at different, temperatures and in different forms. They have the same origin.

7. Various methods of disposing of hydrogen and its safe storage are discussed. It may be stored in the steel lattice or in " imperfections " by either severe cold working and or " cathodic hydrogen treatment."

8. Slow cooling is an efficient way to eliminate fishscaling and reboiling. The process permits the hydrogen in the steel to be transferred into the glass as "OH" ions as a part of its structure.

Discussion

MR. N. S. C. MILLAR asked whether the water present in the raw materials of the frit or the water used to quench it was the more significant source of hydrogen in the enamel.

MR. CHU replied that borax and mill additions did tend to increase the incidence of fishscaling. It was possible to use dehydrated borax, but boric oxide contains a considerable amount of water, which would not be released even if heated to 1200°C.

MR. S. E. A. RYDER said the use of aluminium-killed steel was notoriously liable to result in fishscaling trouble and he asked why this was so.

MR. CHU appreciated that this was an important problem.

The behaviour of steel depended on its thermal and mechanical history as well as on its chemical composition. For example, the cold working of steel to 15 per cent eliminated the fishscaling. Pure iron allowed hydrogen to get through very quickly. But if a killed steel had lots of other metalloid additions—for instance, if it were a high-carbon steel—the permeability to hydrogen was much lower ; it was difficult for hydrogen to get through steel containing 0.35 per cent carbon. In other words, a material having more metalloids, whether hydrogen, carbon, manganese or alloy addition, had lower hydrogen permeability.

Another factor was solubility. The presence of alloy additions, such as nickel, chromium or some others, not only blocked the way of the hydrogen, but could allow the steel to absorb a larger amount and keep it there.

He felt, however, that high purity iron did not necessarily help fishscaling.

MR. J. H. GRAY said he had understood the author to say that in his opinion nickel dip did not prevent the trouble necessarily, but might delay it. Some reference had also been made to heat treatment after the nickel dip.

MR. CHU replied that nickel dipping had always been known to increase adhesion. But he had come to the conclusion that adhesion and fishscaling were not directly, but only indirectly, related. A tightly adherent coating could fishscale because the phenomenon of fishscaling was controlled by many other factors besides adherence.

He had found that if steel were just nickel dipped, but not heat-treated, the hydrogen would go through as fast as when there was no nickel dip ; the heat treatment slowed down the rate

of diffusion. The steel, after dipping, could be heat treated alone or with glass on it. On investigating glass on nickel-dipped steel it was found that the nickel was still on the steel and could not be removed by sand-blasting because the nickel entered into the steel. Because of the increase in solubility of the hydrogen, it was very helpful in retarding or eliminating fishscaling.

DR. W. STEGMAIER asked if the author would elaborate his statement that fishscaling on weldmetal could be avoided by proper treatment along the seam.

MR. CHU said that chipping trouble arose from many sources and if the source was known it could be eliminated ; it could also be eliminated by certain methods without knowing the source. One method was to try to eliminate the hydrogen by a process of slow cooling, which decreased the amount of hydrogen in the weldmetal through the equilibrium curve. As the temperature dropped, the amount of hydrogen would decrease, and if the temperature were brought down slowly it came into the safe range, thus avoiding weld chipping by slow cooling.

DR. STEGMAIER pointed out that the cooling-down time depended on how the material was cooled ; it was determined by the kind of furnace used.

MR. CHU replied that a continuously firing furnace was much more advantageous from that point of view than a batch type furnace, because in the former the cooling down was done gradually, whereas with the batch type the ware was quickly heated and cooled, and there was less advantage in using it. In other words, if the process used were giving trouble the process itself should be examined.

Abstract No. 2

BLISTERING OF WET PROCESS VITREOUS ENAMELS ON CAST IRON — SOME FACTS AND THEORIES

by E. R. Evans, A.I.M. and A. D. Morgan, A.M.I.B.F.**

AS a finish on cooking appliances and other domestic equipment vitreous enamel is superior to any other and the rigidity of cast iron components enhances its virtues. However, the enamelling of iron castings has for many years presented certain problems and, of the defects which can occur, the most serious is blistering. Blistering in varying degrees of severity occurs on many enamelled castings and its occurrence can fluctuate considerably without any apparent corresponding changes of foundry or enamel shop practice. This paper records some of the findings of an investigation carried out by the British Cast Iron Research Association into the problem of blistering mainly from the metallurgical angle.

*British Cast Iron Research Association

As a result of experimental work the following findings are recorded.

(a) If all atmospheric oxygen is excluded, no gas is evolved from the iron on heating.
(b) If oxides are present in the surface of the castings, gases will be evolved on heating even in oxygen-free atmospheres.
(c) Such oxides can be formed in defects in castings or in the surface of apparently sound castings.
(d) Annealing increases the tendency for gases to be evolved from the casting when heated in an oxygen-free atmosphere.
(e) Blistering can still occur when the casting skin has been removed prior to enamelling.
(f) Variations of heating rate during the enamel fusing operation seem to affect blistering.
(g) Inadequately cleaned castings are more likely to blister than adequately cleaned castings.
(h) Prolonged storage of castings before processing increases the tendency to blistering.

On the basis of these findings the theory is put forward that the gases responsible for the blistering of wet-process vitreous enamel applied to cast iron are oxides of carbon formed by direct and indirect oxidation of the carbon in the iron by atmospheric oxygen.

It is claimed that blistering can be minimized at any plant if sufficiently good control can be maintained of all foundry and enamel shop operations.

The casting skin is not necessarily responsible for blistering providing it is sound. Surface and sub-surface defects, however, will cause isolated groups of blisters in many cases.

The temperature cycles of castings during the enamel fusing operation are important and can affect the prevalence of blistering.

The gases responsible for the defect are oxides of carbon formed by interaction between graphite in the iron and oxides or oxygen originating from the atmosphere. The treatment of the casting prior to enamel fusing determines how much oxygen is available to the graphite for potential blister gas formation. There is no intrinsic gas content of cast iron which is in any way responsible for blistering.

Annealing is a process which is unnecessary except as an aid to cleaning. The metallurgical effects of annealing on the iron have little significance and are more likely to promote blistering than to prevent it. This has been illustrated by the study of gas evolution from cast-iron specimens.

Shot-blasting is seldom adequately controlled in plants and yet this operation is probably the most

important of all those concerned with the production of vitreous enamelled iron castings. Rate of surface removal from a casting is dependent on size of grit but is not a criterion of satisfactory surface preparation for cast iron.

Coarse shot tends to damage the surface rather than clean it, thus surface oxides are merely peened into closer contact with graphite and become potential sources of gases causing blistering. Fine shot cleans better and damages the surface less and, in general, produces a better surface for the application of wet-process vitreous enamel.

Discussion

MR. H. WHITTAKER in reference to the temperature of annealing, asked whether there was any advantage in going above the normal temperature of about 760°C.

As regards shotblasting, most of those engaged in cast iron enamelling had arrived at a size of steel grit of about 16, and it was like having boulders flying against the castings. He asked what Mr. Evans would regard as a suitable size, and what was an optimum pressure.

MR. EVANS replied that if the object of annealing was to convert rust to an oxide which was easily removed he imagined it could be done at any temperature above 600-650°C. But such conversions required time, and if one wanted to anneal in a short time one needed to use a higher temperature. He advocated that one should not anneal at all ; that did not apply so much to the jobbing enameller, but to those who could organize their schedules, in other words, those with a fairly quick turn-round.

It had been suggested that if gas were to be released from the iron at some stated temperature, annealing should be at a higher temperature. That was not so, because the higher the temperature and the longer the time of annealing, the more oxide would be caused to penetrate into the iron. It appeared, therefore, that the factor to be considered was the extent to which the oxide would penetrate the iron, and this called for more information about the iron, which could only be obtained by a post mortem ; then, depending on whether the structure was coarse or fine, a decision could be taken as to the form of the annealing process. While the complete answer was not known, it was known that with coarse graphite, annealing was a bad thing, and the longer the time of annealing or the higher the temperature the worse it became. With fine graphite iron the annealing temperature could be increased because there would not be the penetration.

MR. WHITTAKER said he was referring to perfectly good castings having a section of about 3/16th in. but with some areas having a larger cross section.

MR. EVANS said that because the graphite was bigger, and because those areas required longer time to cool down in the foundry, they were likely to have more oxide and were more likely to have burned-on sand. The best cure was to re-design them ; it was a case of trial and error. His view was that by adequate shotblasting, one would probably do better than by annealing followed by a small amount of shotblasting. Annealing was a bad thing, rusting was another. But he still could not answer the question by saying that one should anneal at 800°C. for half an hour or anything like that.

As to a recommended size of grit, he referred to a paper he had presented some time ago in this country, entitled " Some Observations on British Enamelled Iron Castings," which dealt with variations in practice in enamelling shops. In it he had mentioned that the recommended treatment with shotblasting was to use the finest shot possible. People would say that that increased the time, and they had to think about the economics of the process. He did not think it was a matter of the grade—he preferred 22-24 rather than 16—but rather the amount that was taken out. If one took out the fines and had still a number of lumps as big as 3/16th in., one might be in trouble ; but if one separated the dust and struck a happy balance, perhaps the actual grade of shot put into it did not really matter.

DR. STEGMAIER said that, in comparing cast iron with steel, the sources of blistering and all the defects from evolved gases and so on were in the one case carbon gases and in the other hydrogen. In each case ferrite was present, but were " pop-offs " and " spit-outs " in cast iron caused by carbon oxide gases or hydrogen ? The authors of the paper had determined the amount of gases in cast iron before it was enamelled, but they did not say what kinds of gases they were. He asked if they had ever determined the gas content and the kinds of gases, whether carbon oxide or hydrogen, in an enamelled cast iron which had shown the well known defects of " spit-outs." The source would always be carbon oxide gas, for there was no mention of hydrogen, where the cast iron was not enamelled. But if it were enamelled, the possibility of hydrogen should not be overlooked.

MR. EVANS replied that hydrogen was considered, though it was not mentioned specifically in that connexion. The B.C.I.R.A. had examined enamelled as well as un-enamelled specimens, and the results were shown in the paper. What they could not do was to show the differences in the amounts of oxides of carbon and water vapour evolved as between the enamels which finished with a good surface and those which finished with a blistered surface. It appeared that the same sort

of gas was evolved, whether or not the surfaces were blistered.

MR. R. M. WATTERS commented that, if there were a continuous run of blistering in an enamelling shop, it would be customary to change the iron.

In his experience if a casting blistered and was stripped and re-enamelled it gave better results.

MR. EVANS said that if an enamelled casting which had blistered, was shotblasted and enamelled again and it did not blister, that proved the point.

Concerning the remark about changing the iron if there were a continuous run of blistering, he commented that foundries were not infallible, they could produce an iron which would not enamel. But assuming they produced castings which were completely grey, without eutectic carbide and without the sort of defects which were mentioned in the paper, the enamelling shops would stand a reasonable chance.

MR. S. E. A. RYDER speaking of very light castings, said he did not know whether his organisation were particularly unfortunate, but they were finding it increasingly difficult to get pig iron with less than about 0.15 per cent. of chromium, and it caused them much concern. They thought that annealing at higher temperatures and for longer periods should break down the pearlite which might be in the castings.

He called the attention of the industry to this chromium problem, which was a very real one.

MR. EVANS agreed that it was unusual nowadays to get a foundry pig iron with less than 0.1-0.15 per cent chromium, and the B.C.I.R.A. had called the attention of the industry to it. But he pointed out that, if one were running at a silicon content of 2.7 per cent and increased it to 2.9 per cent, the carbide stabilizing effects of chromium would be counteracted.

He also agreed that one of the things achieved by annealing was to reduce the pearlite. This was one of the conjectural things. These irons which retained a little pearlite after enamelling had not been so good as those in which the pearlite was completely broken down. He was certain, from the tests he had made, there was no gas evolved in the breakdown of pearlite ; he did not know why. Obviously there was something in this for investigation.

MR. RYDER remarked that pearlite was bad for enamelling anyhow, and that shotblasting was not so effective on it as it was on grey iron.

MR. EVANS said that, metallurgically speaking, provided the surface was suitably cleaned, he could see no reason why a pearlitic iron should not enamel well.

MR. J. SEMPLE said the tenor of the paper was to suggest that the temperature of fusing of the enamel was likely to be critical. His own view was that, in the temperature range in which cast iron was enamelled, the whole thing was so critical that one would never be completely free of this type of defect.

He put it to Mr. Evans that, with an enamel fusing at 100-160° less than the normal temperature, there would be less blistering.

MR. EVANS replied that, if the frit manufacturers could produce the enamel they were being asked to produce, with high abrasion resistance, high acid and heat resistance, in white or pastel colour, and with a fusion temperature below 680°C., he was sure that would be the answer.

The paper, he added, was essentially a metallurgical one. His organisation was the British Cast Iron Research Association, not the British Cast Iron Enamelling Association, and they had to stick to standard enamelling practices and to examine the problem.

Abstract No. 3

PINHOLES AND POROSITY OF ENAMELLED CAST IRON

*by C. A. Sanders**

THIS paper discusses some of the many variables in foundry practice which can contribute to defects in the enamel coating on iron castings. Most of the defects that occur during the enamelling of iron castings could be cured by modification of foundry technique.

Among the influential factors referred to are the following :—

Surface chilling of castings leading to the presence of combined carbon and consequent gas evolution.

The presence of sulphur in excess of 0.1 per cent which can influence enamel adhesion and quality in a number of ways.

Areas of excessive oxidation which can give rise to gassing due to reaction with carbon and which also cause hardening of the metal surface.

A pearlitic structure which is sometimes considered desirable for machineability and greater mechanical strength but which is unsuitable for enamelling owing to the presence of combined carbon.

Pinholes or porosity in the surface of iron castings which are defined as being of three principal types :

a. Aspiration pinholes caused by air entrained into the gating system during pouring.
b. Evolution pinholes caused by the evolution of dissolved gases during cooling.
c. Reactive pinholes caused by non-metallic inclusions which generate gases under the influence of heat or oxidation or in contact with the metal.

Other contributors to surface porosity are moisture or other contaminants in the moulding

(*Continued in page* 368)

*Vice-President, American Collord Co.

DEVELOPMENTS IN VITREOUS ENAMELLING

by Professor A. I. ANDREWS

(Department of Ceramic Engineering, University of Illinois)

The 1st MELLOR MEMORIAL LECTURE delivered at the Silver Jubilee Conference of the Institute of Vitreous Enamellers

THIS address at the Silver Jubilee Conference Exhibition of the Institute of Vitreous Enamellers honouring its first President, Dr. J. W. Mellor, is a tribute to a man revered all over the World. He contributed not only to enamelling, ceramics, and chemistry, but to science in general, leaving a legacy of published information of inestimable value. How one man could so accurately assimilate, organize and publish the sixteen volumes of his Comprehensive Treatise on Theoretical and Inorganic Chemistry and many other books on chemistry and mathematics with over a hundred technical papers, is difficult to comprehend. Although he exhibited an abiding interest in science in his early life, he had a long hard struggle in gaining the exceptional education which he finally acquired.

We in America, who grew up in our science of ceramics during the period when Dr. Mellor was issuing his Treatise on Chemistry, looked forward with anticipation to the issuance of each volume. His influence in the Ceramic Society, in the Refractories Materials, and the Building Materials sections and in the British Refractories Research Association, as well as the Institute of Vitreous Enamellers was felt by other groups of similar interests throughout all civilized countries. J. W. Mellor is a name recognized by ceramists and chemists as one of the outstanding men of our recent times.

In the present era of rapid development, great progress and changing times, and the tremendous expansion of our knowledge in the sciences, enamelling has surged ahead so rapidly that it is difficult to keep abreast of its progress. The enameller can no longer comfortably coast along on the basis of past knowledge and experience, but must be alert to the opportunities for expansion in the uses of enamels as a material not only of beauty, but utility. Vitreous enamels have an important part to play in the rapidly growing science of engineering materials. Its durability as a material for construction, corrosion resistance and permanence offers a challenge to the foresight and ingenuity of all of us. The opportunities in architecture are almost unlimited and its use in equipment for the conquering of corrosion problems not only in the home, but in industry, agriculture, chemistry, food preservation, and transportation under varied environments of temperature, solution, radiation, and physical changes challenge the imagination.

The potential markets within these areas have only been scratched, as the production required to satisfy even one of these demands could easily multiply the volume of our whole industry. We need, not only the application of science, but also engineering. A typical example of this is the development of the domestic hot water heater which the industry would not touch until one manufacturer, through engineering development, demonstrated that it was feasible. A few years later the industry expanded and at present 2,700,000 enamelled heaters are manufactured in the United States annually. Only 1,000,000 are manufactured from all of the other materials combined.

Other products such as furnaces, smoke stacks, silos, and tanks could reach great volumes. Enamels are engineering materials eminently suited to corrosion resistance, and with the application of cathodic protection their use should be greatly extended.

Organizations such as the Institute of Vitreous Enamellers must lead the way in bringing the realization of these opportunities to the enameller.

In an address such as this it is impossible to go into details with regard to the recent progress and the developments that are under way, but a review will point out the general trends and a pattern for the future.

Metal Progress

In the early part of the century, iron enamelling sheets varied over a wide range of composition and properties. Low carbon content was preferred but what specifications there were had to be very broad. The introduction of low carbon low manganese sheets, in 1912, later known as enamelling iron, was a great improvement as it gave the enameller a fairly standard material. This standard

Table I

Typical Percentage Compositions of Steel Used for Enamelling.

	Carbon	Manganese	Phosphorus	Sulphus	Titanium	Silicon
Enamelling Iron	.03	.04	.010	.030		
Cold Rolled Mild Rimmed Steel	.08	.35	.015	.030		
Ti-Namel	.05	.30	.010	.030	0.30	0.1

induced better specifications for cold rolled low carbon stock and made possible enamelling on a large scale.

Today cold rolled low carbon steel, enamelling iron, and special steels are used extensively for enamelling. Their compositions are shown in Table I.

Each of these irons have their advantages and their disadvantages. Although cold rolled low carbon enamelling sheets are economical for enamelling, they tend to sag and warp at ordinary enamelling temperatures and have a tendency to develop copperheads, blisters, black specks, and fishscaling. Their chemistry, their physicals and their surfaces vary considerably.

Enamelling irons are a decided improvement over cold rolled low carbon sheets but they are more expensive to manufacture because of their low manganese content, which requires special rolling and normalizing. They usually have a better surface, do not sag or warp at ordinary enamelling temperatures and are not so prone to develop defects.

The third class of sheets used for enamelling is the special steels. Although some of these depend upon special surface treatments, the most common is Ti-Namel which is a basic open hearth fully killed steel, containing titanium and manganese but otherwise it is not unlike enamelling iron in composition. It has the advantage over other enamelling irons in that it does not involve the violent boiling of the enamel during firing, making it particularly suited for one-coat white application. These special steels are, however, very expensive and although used in production they have not been generally accepted.

A great deal of research and development is at the present time pointed to special surface treatments of the more common enamelling sheets right to the enamel plant. The use of special cleaning, phosphoric acid pickling, and the deposition of nickel is showing great promise. If successful, these treatments will reduce the importance of variations in the surface of the metal. The current objectives call for the use of these treatments with lower firing cover enamels directly on cold rolled stock. For competitive reasons we urgently need a process for producing one-coat white directly on steel.

Considerable progress has been made on this problem and each year we get closer to our objective and the probability for success looks more promising. Only by review and analysis of available data plus continued research and development on the steel, the process, and the enamel can we accomplish the results we desire.

A review of the facts with regard to our present knowledge of the relationships between the enamel and the iron is as follows :

Small percentages of cobalt oxide, 0.15 to 0.5 per cent, give to sheet steel enamels an adherence to the metal after firing. No other material is as effective as cobalt oxide. Nickel oxide has a slight effect when added to the glass, but when concentrated at the interface between the enamel and the iron it has a definite effect in improving adherence. It seems as though the explanation of why cobalt gives this adherence would be simple to determine, but even after hundreds of researches on the problem by outstanding scientists no acceptable explanation is yet available.

Many theories have been suggested and at times it has seemed that the problem was solved only to find new inconsistencies. Before discussing these theories which may contain the key to successful white direct on steel, it is desirable to review some of the facts.

At some time during firing the following are true :

(a) Iron oxide is necessary at the iron enamel interface.
(b) Iron oxide dissolves in the enamel glass.
(c) Water in solution in the glass reacts with the iron to form iron oxide and hydrogen.
(d) Dendrites of iron, cobalt, nickel and alloys of them form at the interface.
(e) Hydrogen, from the reduction of the water dissolved in the glass, enters the iron.
(f) Molecular hydrogen trapped at the interface either during or after firing causes reboiling and fishscaling.
(g) Ionic or atomic hydrogen passes easily through iron or glass but molecular hydrogen will not pass through either, except as transferred as bubbles in the glass or riffs in the iron.
(h) Hydrogen is present as ions, atoms, molecules, hydrides or water.
(i) Gases reported to be evolved during firing are hydrogen, carbon monoxide, carbon dioxide, carbon hydrides, nitrogen, and water.
(j) Water is in solution in all glasses.
(k) Since the glass is an electrolyte when molten, plating can take place.
(l) An oxidizing atmosphere is necessary in the early stages of firing.

The theories for enamel adherence are numerous and the bibliographies are extensive. The principal theories can, however, be classed under the following :

(1) The electrolytic theory is based on the plating

of all metals from iron through copper in the electromotive series on the iron. These platings are believed to form the bond between the enamel and the iron.

(2) The oxide layer theory claims that an iron oxide layer between the enamel and the iron is responsible for the bond.

(3) The hydrogen reduction theory claims that the oxide of cobalt is a sacrificial material in that it is reduced to cobalt by the hydrogen to permit an intimate contact and adherence of the enamel to the metal.

(4) The mechanical theory claims that the enamel adheres to the iron because of surface roughening by etching or blasting which gives irregularities to which the enamel can hold.

(5) The dendrite theory postulates that the dendrites formed by the reduction of iron and the growth of iron crystals at the interface serve as projections to hold the enamel to the iron.

(6) The atomic attraction theory claims that any glass which is high in the lowest valence oxide of the metal to which it is applied, at the interface, adheres to the metal.

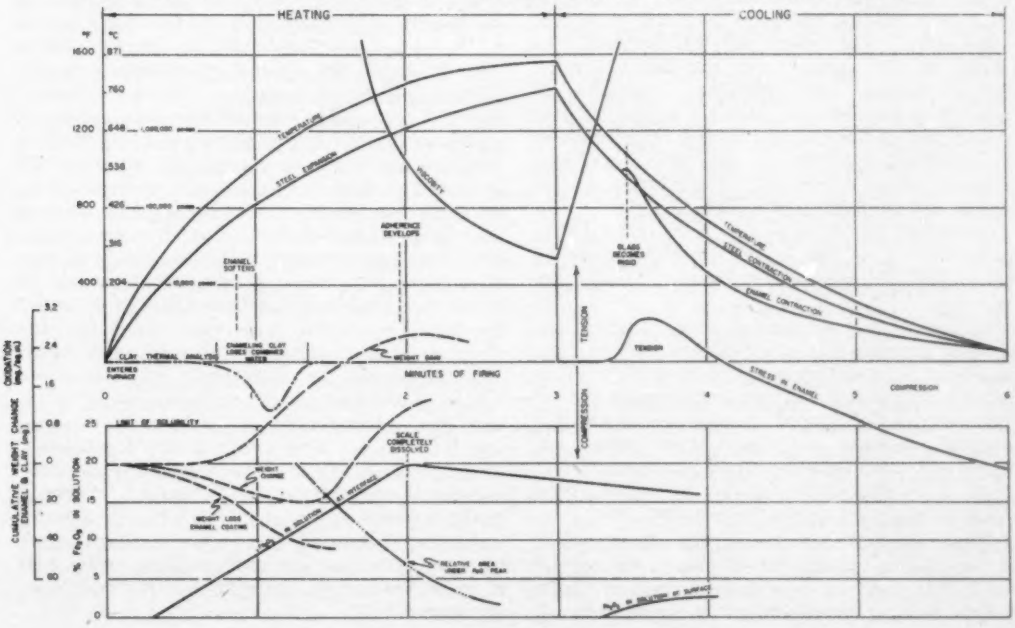
It is probable that not one but several of these theories contribute to adherence. Information and the results of experiments are extensive in the literature and could not be covered in this paper.

The author favours the combination of the hydrogen reduction theory and the atomic attraction theory. The atomic attraction theory does not stand alone as the function of cobalt and the role of hydrogen are not adequately accounted for. The hydrogen reduction theory explains the function of both but does not explain why the enamel adheres to the iron. The hydrogen theory actually considers hydrogen as a hindrance which must be eliminated at the interface to obtain intimate contact between the glass and the iron. The iron oxide is necessary to consume the hydrogen which reduces it to iron with the formation of water which goes into solution in the glass. The cobalt oxide is necessary to supplement the action of iron oxide, its function being a buffer as it diffuses out of the glass to the interface. Iron forms solid solutions with cobalt, therefore they are compatible. Nickel oxide when at the interface also carries out the function of iron oxide in oxidizing the hydrogen to water. Once the molecular hydrogen is completely eliminated at the interface, the glass being loaded with ferrous oxide at the interface is attracted strongly by the iron metal. No doubt roughness which gives more surface aids the adherence.

A wealth of data and relationships is shown by A. L. Friedberg[6] in his compilation of firing phenomena for sheet iron ground coats and a titanium cover enamel in Figs. 1 and 2.

Fig. 1 shows the relationships of the properties while firing a sheet iron ground coat in a box type

Fig. 1—Variations in relations of the properties of a sheet iron ground coat during firing in a box muffle.



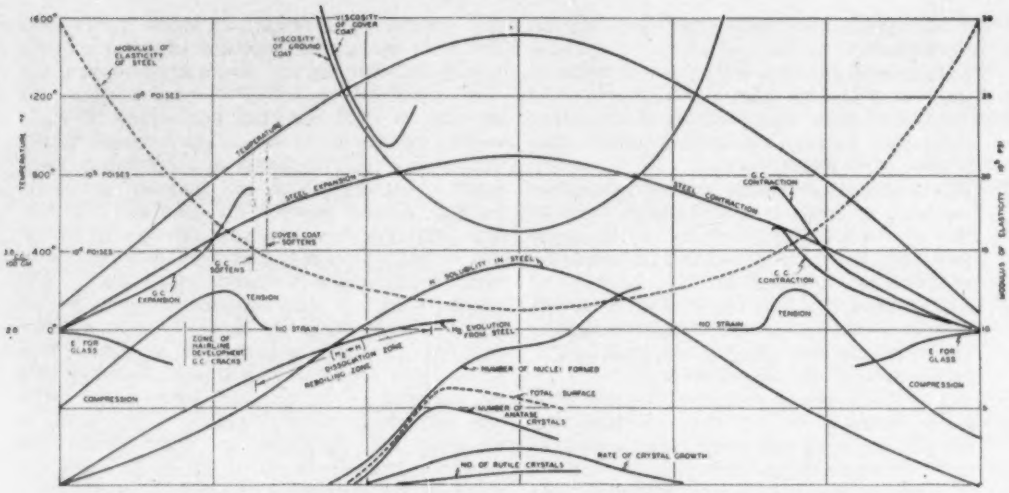


Fig. 2—Variations in the relations of ground coat to cover coat during firing in a continuous furnace.

furnace with a six-minute firing schedule. The ordinate shows the temperature of the ware, steel expansion and contraction, viscosity of the enamel, enamel contraction, stress in the enamel, weight losses and gains, thermal changes and iron oxide solution.

Fig. 2 shows the relationships of the ground coat to a titanium cover enamel fired in a continuous furnace on a twelve-minute schedule, six minutes being required for the ware to reach maximum temperature. The temperature of the ware, viscosities of the ground coat and cover enamel, steel expansion and contraction, modulus of elasticity of the steel and glass, the expansions and contractions of the ground coat and cover enamels, the hydrogen solubility in the steel, hydrogen evolution, strain curves and the nucleation, crystal growth and the relation of anatase to rutile.

Correlated data such as this gives one a better understanding of the overall problems involved and should be extended to many of our other processes.

Aluminium for enamelling requires low temperature enamels because of its low melting temperature. The surface preparation of pure aluminium is simple as it only required cleaning but the alloys all require special chrome treatments and in some processes pre-firing. Many drawn, extruded and cast aluminium alloys can be enamelled. They are particularly popular for architectural panels as corrosion defects do not show rust.

Aluminium-coated steel sheets have also appeared on the market but are not at present extensively used. They are stronger than aluminium sheets and the staining because of rust is greatly reduced.

Enamels

Great progress has been made in recent years in the development of superior sheet iron cover enamels. Enamels of the fluoride type, the antimony super opaques, and the zircon enamels are rapidly giving way to the titanium enamel. This was largely brought about by the development of special pure titanium oxide. The enameller, however, has done a remarkable job of research in the development of these enamels. They are of the recrystallizing type. The titanium oxide is included in the frit batch and is completely dissolved in the enamel during smelting. On firing, however, the TiO_2 crystallizes out of the glass, giving a myriad of tiny crystals of anatase and rutile. The investigations of the nucleation, and crystal growth as related to the composition and the treatments, by many enamellers, has resulted in a superior type of sheet steel cover enamel. These enamels have excellent reflectances, and covering power. They have good working properties, are low in bubble structure and are very resistant to acids. Special compositions have been developed for alkali resistance, abrasion resistance and gloss. Matt enamels are also available.

One of the greatest difficulties in the development of titanium enamels was the control of colour and reflectance. This involved the composition of the glass, the purity of the titanium oxide used, and the control of the crystallization. A review of the research in this area would be a long story and a very interesting one involving contributions by a very great number of enamellers. This type of enamel has not yet been applied to dry process cast iron.

The problems yet facing us involve the development of better low temperature enamels and whites that can be more successfully applied directly on sheet iron without a ground coat. Since many of the steel defects are encountered at higher temperatures of firing, lower temperature enamels may relieve this. The sagging and warping tendency of mild cold rolled stock could be largely avoided.

Sheet iron ground coat enamels have been greatly improved, both from the standpoint of slip properties and firing properties, by the use of two or more frits. These frits differ in their water solubilities in the slip, and in their fusion temperatures. Many combinations have been studied and superior properties greatly decreasing the occurrence of defects, the lowering of firing temperature, and the lengthening of their firing ranges have been developed.

The special enamels custom-made for resistance to hot water, weather, and a wide variety of chemical solutions, and the unique methods of processing have greatly widened the market for enamels. The electrical insulating properties of enamels offer an ideal condition for the use of cathodic protection which has already found extensive application. These electrical properties are, along with the high temperature properties, the basis of many electrical gadgets, and are showing promise for use as wire insulation at elevated temperatures. As adhesives, enamels are attracting wide-spread interest as they are superior to all other adhesives at elevated temperatures. The aluminium enamels are in general lead-containing frits related in composition to the glass enamels. Their development has opened an entirely new area in enamel production.

High temperature enamels (ceramic coatings) made their appearance during World War II and have found many applications. Although superior on special steel alloys, they are also used on enamelling iron. Such products as unit heaters, smoke stacks and flues are examples of high temperature uses on enamelling iron. The ceramic coatings which are used for higher temperatures are generally applied to high temperature alloys to give longer life to the product and to control the absorption, reflection, and emission of infra-red rays.

Processing

In processing, the adoption of continuous conveyors and automatic equipment stand out as great improvements in uniformity and economy of production.

Continuous smelters have become very common and have contributed greatly to the uniformity of the frit. Temperature, atmosphere and material control has been greatly improved. Roll quenching of frit contributes greater uniformity, less contamination and solution, and eliminates drying.

The electric smelter offers some substantial advantages from the standpoint of uniformity and atmospheric control. The water in sheet steel ground coat frits can by this process be reduced to a minimum with a decrease in the fishscaling tendency.

Continuous furnaces greatly reduce labour, improve quality and uniformity and facilitate the uniform flow of ware through the plant. Automatic dipping and draining, beading machines, automatic sprayers, automatic cleaning, pickling, nickel application and neutralizing machines, as well as automated milling, screening and conveying of the slip, are aids to uniform economical production. The introduction of low pressure spraying, air conditioning, control of the water by de-ionization, the re-circulating dip tank and the efficient economical recovery of spray dust and residues are a few of the other improvements.

Properties, Tests and Control

With the expansion of the uses of enamels, the accumulation of physical and engineering data has become more and more important. The definition of terms and the standardization of tests are necessary to the writing of specifications. These are not always easy to accomplish, however, because of the necessity that many points of view be satisfied and agreement reached to assure general acceptance. Independent tests and specifications lead to confusion and comparisons are not possible.

Usually, the standardization of tests leads to research for improving the property and much higher quality is obtained. The development of standard tests and equipment for the reflectance of white enamels has led to a whole series of improvements. To realize this, one needs only to reflect on the continuous progress in regard to reflectance over the past years. Not only did this standard test give a means of measuring that property, but it brought forth the need for accurately measuring enamel coating thickness, gloss, and colour. Magnetic thickness gauges were soon developed and are now used not only in relation to reflectance but as control instruments, since thickness so greatly influences other properties of enamels. Soon after the adoption of the reflectance test, the realization that whites could be blue white, yellow white or other colours became evident. This led to studies of the colour curves and equipment for accurately determining them. Thus the enameller, became interested in the principles of colour, the terms describing colour, and the specifications in terms of trichromatic coefficients. The colour difference measurement became important as a precise method and by correlating the colour data with composition and processing, exact control became a reality. Although the human eye is unable to measure colour, it is a wonderfully sensitive indicator of colour,

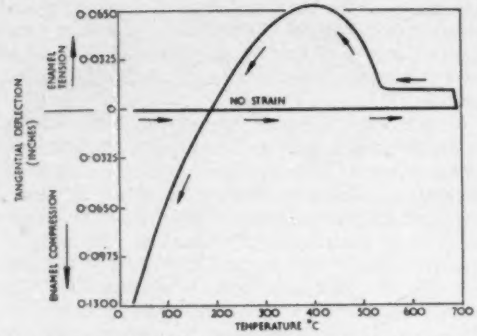


Fig. 3—Thermal deflection behaviour of an enamelled iron strip from bisque to fired state

and had demanded these studies to satisfy its requirements for accurate control. The consideration of gloss in its relation to reflectance and colour became important, therefore, measurements for gloss also became important. Thus one test reflectance, led to a whole series of tests and the necessity for knowledge of many properties.

Gloss determinations led to methods for measuring acid resistance, alkali resistance, water, and weather resistance and even abrasion resistance. Not all these tests are standardized but they should be, and they should be worldwide.

Many other optical chemical, physical, mechanical thermal, and electrical tests too numerous even to mention here should be standardized, data accumulated, classified and made available not only to the enameller, but to scientists, engineers, architects and others interested in using enamels on metals.

The study of rheology has taught the enameller the properties and the control of the properties of slips. This not only has eliminated one of the enamellers' great areas of mystery and uncertainty but has led to the continuous methods and accurate control in automatic dipping, spraying, and draining.

Prior to the studies of stress and strain in composite enamelled specimens, we depended entirely on thermal expansion data using unrealistic conditions. We are now learning much in this area and can better design and process our ware.

All enamellers are aware of the bending of an enamel piece when the enamel is applied to only one side. This is because the thermal expansion, and therefore the contraction of the enamel, is less than that of the iron. The enamel is under compressiom, as it should be, as glass is far stronger under compression than under tension. Many will also remember seeing a flat sheet, where there is more enamel on one side than the other, as in signs, bend towards the thick side at high temperatures and then reverse the bend to the thin side as the ware cools. This reversal is of importance to enamellers since when studied it furnishes us with data whereby we can advantageously heat treat enamel ware as an aid to controlling the amount of compression we wish the enamel on the ware to have at room temperatures. These strains affect hairlining, chipping, strength, rigidity, and other properties.

The reason for the reversal mentioned is the difference in the rate of expansion of the enamel at low and at high temperatures. The rate of expansion is fairly constant for iron, giving it a straight line thermal expansion curve. Enamel, however, has a lower rate of expansion at low temperatures, but at annealing temperatures its rate increases rapidly and its curve crosses the iron curve, rising rapidly as fusion is approached.

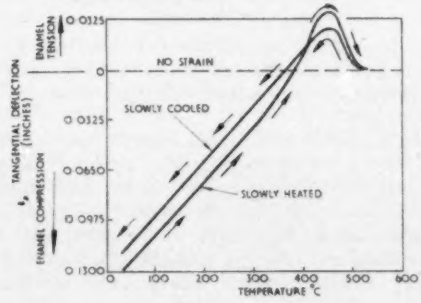
Fig. 3 shows the stress and strain during the firing of a ground coat enamel on only one side of a specimen. On heating, the iron expands, and because the enamel is in the bisque condition it goes along with the iron with no deflection of the specimen. As the enamel softens, it expands rapidly but the viscosity is so low that no deflection develops.

If the specimen is at this point taken from the furnace and allowed to cool rapidly the surface is instantaneously cooled, putting the specimen into deflection even though the viscosity of the enamel is low. Allowed to cool slowly the effectiveness of the high contraction of the enamel would be relieved by its mobility and would cause only a slight deflection. As the enamel becomes more viscous at lower temperatures the contraction causes greater deflection of the specimen until a point is reached where the rate of contraction of the enamel and the iron are equal. From that point, at the peak of the curve, the iron contracts faster than the enamel and the deflection decreases to the no-strain line after which it reverses direction and the enamel is put under compression, the amount increasing to room temperature.

Fig. 4 shows the specimen behaviour on reheating. It starts with the enamel under compression, this

(*Continued in page* 373)

Fig. 4.—Thermal deflection behaviour of an air-cooled enamelled iron strip



Metal Finishing Technology — A Students' Guide

An Introduction to the Examination Syllabus in Metal Finishing of the City and Guilds of London Institute

Compiled by A. ALEXANDER

Foreword

THE City and Guilds of London Institute has recently published a Syllabus covering a Scheme of Examination to provide a specialist qualification for those seeking supervisory, managerial, and technological appointments in the metal-finishing industry. There has for some time been a Metal Finishing Practice Certificate, but this is only intended for plant operators and is a very elementary examination. The present 17B Syllabus covers the whole subject of metal finishing at a fairly high level. The course is intended to occupy three years of part-time study at the end of which there will be an examination. A successful candidate may then take the Institute's examination in Engineering Planning, Estimating and Costing and also further examinations in Metal Finishing based on his actual works experience. If he satisfies the Institute in these two subjects he will be awarded a Full Technological Certificate which will enable him if he so wishes to go forward to obtain the City and Guilds Insignia Award.

It is proposed in this series of articles to work through the Syllabus and particularly to concentrate on those parts of it which will not be found in an ordinary text-book on electrodeposition or paint technology. The Syllabus covers a wide range and over-laps several other subjects, for example metallurgy and electrical engineering. At the same time a man concerned with Metal Finishing does not require to take a full course in these subjects but only to know those parts of them with which he is directly concerned. Undoubtedly if he were able to take a complete course in all the ancillary subjects concerned it would be to his advantage but the majority of people will not be able to give the time to do this as it would occupy several years of full-time study. It is the intention of the author, therefore, in these articles to deal with these as far as possible, but to assume that the reader will also have at hand the normal text-books on his own subject. It is also assumed that the reader will have an elementary knowledge of chemistry, physics and mathematics.

It is not suggested that a series of articles of this nature can in any way supplant a course at a Technological College. Unfortunately however, such courses in this subject are not available to everyone for at the present moment at any rate they are only being run in one or two centres. It is hoped that these articles may be of assistance to those who are taking a recognized course and also to those who are unable to attend such a course but who are trying to prepare themselves by private reading possibly with the help of a private instructor.

The City and Guilds Syllabus is of course an examination syllabus, that is to say it is put forward with the idea that those who follow this course of instruction will sit for the examination and obtain a Certificate. While this Certificate is undoubtedly desirable it is not really, however, the final aim. The Syllabus has been worked out by a Committee consisting of people from the industry to cover the knowledge that a man taking charge of a metal-finishing shop should possess in order to carry out his work efficiently. Whether or not the reader decides to sit for an examination it is obviously to his advantage to study the subjects set out in the syllabus. It is hoped, therefore, that this series of articles may prove useful to many people who have at this time no intention of sitting for the examination.

METAL FINISHING PLANT AND PRACTICE

Introduction

History and Purposes of Metal Finishing

Ever since metals were first used by man some type of finishing processes have been applied to them. Probably the earliest was polishing and there is some evidence that Neolithic man polished his various metal implements with stones, and remains of such stones shaped to a convenient form have been discovered. Evidence of polishing has also been found in some of the ancient historical records as early as the first century B.C. and a number of old drawings and prints exist showing the methods used for polishing armour etc. in the middle ages. Electroplating is a considerably more recent process and dates back to the early eighteen hundreds, one of the earliest books being published in 1841 by Smee. Silver plating which was probably the first process to be used in any scale commercially started towards the end of the century. During the early part of the twentieth

century a considerable amount of silver and nickel plating was carried out, but cadmium and chromium were not used to any extent until the early 1930's. Since that date the amount of electroplating has very materially increased until today it is quite a large industry.

Paint is of course much older and various types of paints were known to the ancients. They were not however used for protecting metals to any large extent. Up to the beginning of the nineteenth century the majority of paints were based on natural oils together with such pigments as red and white lead. However, after the first world war, companies who had been manufacturing explosives etc. turned their attention to making compounds which could be used for the manufacture of special paints and lacquers, and today a large proportion of all the paints used in metal finishing are made from synthetic materials.

The purpose of metal finishing processes are usually to (a) protect the underlying metal and (b) to enhance its appearance. It is only necessary to see a modern car and consider what would happen if such processes were not used, to appreciate the importance of good finishing. In the first place the car would lack eye appeal since it would be constructed of steel plate probably still having a millscale on it. Also, after it had been out once or twice in the rain it would begin to rust and would soon become functionally useless. It is, therefore, necessary, particularly if the car is going to compete in both home and foreign markets, for it to be properly finished. It could of course be completely coated with a fairly thick type of protective paint which would preserve it from atmospheric corrosion but the majority of people like their cars to have a smooth shiny surface. It is, therefore, necessary to choose a paint which will not only protect the underlying steel plate but which also will have an attractive colour and a glossy surface from which the dust and dirt accumulated on the road can be easily wiped. A car, however, completely painted like those produced during the war period does not have a very great eye appeal and most purchasers like to have at least some part of the vehicle showing a polished metal surface. This surface will reflect and gives an impression of motion to the surface which attracts attention and increases its appeal. Also such metal surfaces do not show scratches or chips to the same extent as a paint surface and for this reason the bumper bars, name plates, door handles etc. are usually chosen for plating. If these were left as polished steel they would soon tarnish and rust and for this reason they are normally plated with a nickel deposit and finished with a thin layer of chromium which resists atmospheric tarnish so that they remain bright without polishing.

Unfortunately one of the difficulties with all metal-finishing processes particularly electroplating is that it is impossible to inspect the finished article satisfactorily without destroying it. Unless the processes are carefully and properly carried out there is a great danger that the article will not perform satisfactorily in service. At the present time there is no really satisfactory method of testing this without destroying the finished article and so only a small number of articles out of a large batch can be tested to see whether the work has been satisfactorily carried out. It will be obvious, therefore, that the onus of producing work will lie with the people in charge of the various metal finishing shops throughout the country, and the success of our export trade may often lie with the finish applied to the articles exported. Since this country depends largely on exports it is obvious that this subject is an extremely important, one and therefore those who are to take charge of metal finishing operations should be properly qualified. It is for this reason that a very great deal of thought and work has been put into the City and Guilds Syllabus.

Outline of Corrosion Theory

It has been said that as soon as the metallurgist produces a piece of iron from its ore (iron oxide) it immediately tries to revert to its original form; in other words it has a strong tendency to be attacked by the oxygen of the air. Materials can be divided roughly into two classes, the so called noble materials such as gold and platinum which resist atmospheric attack, and the base materials, copper, lead, zinc and iron which are liable to be attacked under normal conditions.

Unfortunately those materials which best resist attack by the atmosphere are relatively expensive, difficult to work, and often do not possess the necessary mechanical properties to enable them to be used for many purposes. It is, therefore, necessary for most processes today to use materials which are subject to corrosion under the conditions in which they will be used.

A considerable amount of work has been done to discover the exact mechanism by which the metal is attached. It has been found that the action of the corroding medium is not usually a purely chemical one but that an electro-chemical action is involved, that is to say a current flows through the metal making some parts of the surfaces negative and some positive to the surrounding media. It has been found that the surface of a metal is not completely homogeneous. Even, therefore, where a single metal is involved parts of it will have a different potential to other parts. If the surface then becomes covered with a solution which will conduct electricity the current will flow from one part of the surface to another through the solution. That part of the surface which functions as the anode will corrode while the part that functions

as a cathode will be protected. Where two dissimilar materials are in contact an electric potential will be set up and this will normally result in the corrosion of the material that is anodic being very considerably accelerated. On the other hand the cathodic metal will be protected and it is possible, therefore, to protect a metal by coating it with another metal which produces this effect. For example with steel coated with a thin layer of zinc, the zinc will be attacked in preference to the steel even at those points where the steel is not completely covered. The zinc, however, will itself gradually corrode away and of course when it has all gone it will give no further protection. On the other hand it is possible to protect a piece of steel with a layer of nickel which itself resists corrosion fairly well. In this case, however, the nickel is only an envelope. If the envelope is not completely continuous, for example if there is a small pore in the layer, then the steel at the base of this pore will corrode preferentially to the nickel and in fact it will corrode very much more quickly than if the nickel was not there.

The amount of corrosion that takes place is proportional to the amount of current that flows from one part of the surface to another. If a fairly large flat surface of nickel-plated steel with a small pore in the centre is considered then it will be seen that there is a large cathode area and a small anode area. If this surface becomes coated with moisture an electrolytic cell is set up. Atmospheric moisture contains small quantities of such substances as sulphur dioxide and nitrates and thus it will be possible for the steel exposed at the pore to dissolve under the influence of the current. If the pore is very small and the deposit fairly thick the current will be reduced and under certain circumstances the corrosion products produced may block the pit altogether and stop further action.

It will be seen that it is necessary for moisture to be present. In a perfectly dry atmosphere iron does not rust but, particularly in this country, the atmosphere is never dry and sometimes it is highly charged with moisture. Usually, therefore, a thin film of moisture will be present on a metal surface, particularly when this surface is somewhat colder than the surrounding air.

It is difficult to visualize exactly what will happen when any two metals are used in contact as for example an electroplated article. If the plating forms the cathode then the underlying metal will tend to corrode at any discontinuity, *i.e.* a pore or a crack. If on the other hand the plating is the anode, as it would be in the case of zinc-plated steel, then the plating itself will tend to corrode and the life of the article will largely depend on the thickness of the plating and how long it takes to be attacked under the conditions of service.

Where paint films are being dealt with the conditions are somewhat different as these films do not conduct electricity and, therefore, do not produce currents between the film and the underlying metal. It has been found, however, that under certain conditions, particularly corrosion by sea water, blisters form under the paint and it has been shown that these blisters are of two kinds, *viz.* one in which the metal underneath has become anodic and one in which it is cathodic. It would appear, therefore, that even under these conditions there is a small current flowing between different portions of the surface which accelerates corrosion. Normally the paint film protects the underlying metal by producing an impervious envelope but the average paint film is usually slightly porous to moisture and this leads to ultimate breakdown, the moisture getting through the film and producing a conducting path between two parts of the surface. These two parts may be quite close together so that effect the corrosion appears to be centred at a local spot but it is important to realize that corrosion is an electrochemical process and not a purely chemical reaction. It has been found for instance that if very pure zinc, practically free from any contamination by other materials, will not dissolve in dilute sulphuric acid. Although the solution of zinc in acid is usually looked upon as a purely chemical reaction this shows that if the zinc surface is completely homogeneous, that is to say if the zinc is completely free from impurities so that every point on the surface is the same, then the action will not take place.

General Principles and Surface Coating of Materials

There are a number of different methods of coating a metal surface. One may wish to coat it with another metal, an inorganic metallic salt, or a coating of paint which is either entirely organic or may be an inorganic pigment held in an organic binder. There are various methods of doing this and an outline of them will be given here :—

Mechanical Methods

Coatings of one metal on another can be obtained by purely chemical methods without the application of an outside current. These methods may be divided into two classes.

Simple Immersion: If a piece of steel is placed in a solution of copper sulphate a loose copper coating will form on the surface. Some of the iron from the surface will dissolve into the solution replacing the copper which will then precipitate out on to the surface. In this case a loose coating is produced which is quite useless but by using a different type of salt it is often possible to obtain a smooth adherent coating although such coatings are very thin because as soon as the metal surface

has become completely coated the action stops. It is possible for instance to produce a thin coating of silver or brass or copper by dipping it into a silver cyanide solution. Such coatings, however, are not of great importance technically as they are too thin to be of very much use.

"*Electro-less*" *Coatings.* It is also possible to produce coatings on metal by chemical reduction of the metal salts in the solution. Perhaps the best known example is the silvering of glass by reducing the silver from an ammoniacal solution of silver nitrate with a suitable reducing agent such as formaldehyde. More recently a process of plating nickel by reducing a nickel solution with hypophosphites has been worked out. Since the basis metal is not involved in the reaction, it is possible to build up quite thick deposits. Actually these deposits are not quite pure nickel but contain a small percentage of phosphorus but they are useful and the process is used for certain processes.

Replacement from Vapour Phase

Certain materials can be coated by treating them with a metal which will vaporize at a comparatively low temperature. Probably the best example of this is the process known as sherardizing. This consists of putting the articles, together with a quantity of zinc dust, into a steel drum, heating the drum, and rotating it. Under these circumstances the zinc vaporizes slightly and the vapour condenses on the surface of the steel articles to form a zinc surface. Actually an alloy layer is first formed and then zinc continues to deposit on this. In some cases also metal deposits can be formed by treating the article with a gas containing a metal compound.

Vacuum Sputter and Evaporation

This process consists of suspending the article to be coated in a high vacuum and sputtering metal onto it by a high-voltage electric discharge. Alternatively some metals can be deposited by vapourizing them into the vacuum chamber by means of heat. The process will coat both metals and non-conductors.

Metal Spraying

This process is carried out by means of a spray gun. In the gun, metal in the form of a wire or a powder is fed into an oxyacetylene flame. A blast of compressed air blows the atomized metal from the gun on to the surface of the article to be coated where it deposits as solid metal particles. If the article is properly prepared an adhesive layer of metal can be produced on this surface. This process is generally used for coating steel with aluminium or zinc and is particularly useful for dealing with large structures which cannot usually be treated by other methods.

Hot-Dipping

It is often possible to produce a coating of metal by dipping an article in a bath of molten metal. The commonest process of this type is galvanizing. The name of course is a misnomer as it does not employ the use of an electric current but it has now been so long used in the trade that it is generally understood to apply to the hot-dipping process. Sometimes zinc plating is referred to as electro-galvanizing but this term is now deprecated. Zinc and tin are the general metals applied in this way; iron and steel articles can be coated with both zinc and tin, and brass articles with tin only.

Cementation

This process consists in heating a metal usually steel with a compound of a metal such as chromium to a fairly high temperature in a steel box. Under these circumstances the chromium compound is broken up and the chromium penetrates the steel surface forming an alloy layer. The process has some advantages but has not found great favour to date, one of the principle disadvantages being the tendency to produce distortion in the original article due to the heat. It is also fairly expensive to carry out particularly if the articles are of such a shape that a number of them cannot easily be packed into a box.

Electrolytic Methods

This covers the electroplating processes. The metal is deposited from a solution by passing an electric current through the system, the article being made the cathode and the anode being of the same metal as that to be deposited; in certain cases an insoluble anode is used. As these processes are to be dealt with in considerable detail later it is not proposed to say any more about them here.

Inorganic and Organic Coatings

Inorganic: A coating of certain metal salts will protect the underlying metal if it is formed on the surface and adheres satisfactorily. Probably the best example of this is the phosphate coatings on steel. By dipping the steel article into a solution of phosphoric acid or certain phosphates it is possible to produce a coating of phosphate on the steel surface. This coating adheres quite well and protects the surface while it will also take up dyes and oil which give it additional protection and a more decorative appearance. Coatings of sulphide can also be produced on copper and silver and are used for certain decorative finishes for example "oxy-copper." These coatings, however, have no great protection value and usually require to be coated with lacquer to stop them from tarnishing.

Organic: These include paints, lacquers and enamels. They may be applied either by brushing, spraying, roller coatings flow coating, electrostatic spraying, or dipping. Since these coatings will also be dealt with at considerable length later in this series it is not proposed to deal with them further here.

(*Series to be continued*)

A Quarterly Survey of some of the Features in Finishing Literature from Abroad

by SCRUTATOR

Topical

BEFORE proceeding to the usual survey of the more interesting features of finishing literature from abroad, it is perhaps not out of place to make some reference to the Fifth International Conference on Electrodeposition and Metal Finishing held in Detroit, U.S.A. in June. Reports on the technical aspects, views on the "Conference in Retrospect" and many expert opinions of the Conference have been and are being given in finishing journals in both this country and abroad.

In due course all the papers will be published so that all can read what some were fortunate enough to hear. This is obviously, therefore, not the place to attempt to review the 44 lectures given over a period of 5 days, which in any case would be impossible as with the exception of the first day, there were always two lecture sessions in progress at the same time. It was thus physically impossible for any one person to attend all the lectures, which was particularly disappointing as preprints were not available for any of the papers.

The Fifth Industrial Finishing Exposition held at the Detroit Artillery Armory was undoubtedly the biggest and best exhibition dealing with metal finishing which has ever been staged and over 140 companies exhibited. It was extremely well planned and arranged and two complete afternoons were required to visit all the exhibits. Apart from the anticipated emphasis on flat polishing, duplex plating, crack-free chrome, better and brighter nickel, etc. etc., the following less glamorous features attracted attention—for heating processing or plating solutions, sheet metal "plate coils" or "thermo-panels" have much to recommend them as compared with the more orthodox steam or high pressure hot water heating coils manufactured from steel tubing. For one thing they are much easier to clean. One company was exhibiting a methylene chloride, trichlorethylene or perchlorethylene vapour degreaser which incorporated refrigeration as a means of vapour control in place of the usual water cooling. Here obvious advantages would seem to be no water and hence no plumbing, less evaporation with consequent solvent savings. Bright zinc plating followed by colourless chromating with or without dyeing was displayed on many stands and there was a full scale demonstration of an electrostatic hand paint spray gun. These were but a few of the many interesting exhibits and demonstrations.

Still on topical subjects, Mr. Nixon's visit to the American National Exhibition in Moscow and his "discussions" with Mr. Kruschev hit world head lines. Mr. Khruschev's visit before the Exhibition was officially opened, however, received nowhere near such wide publicity[1]. Apparently, this was to see the erection of the 200 ft. diameter gold-anodized Kaiser Aluminium dome which was composed of 110 diamond panels, which is claimed to be the largest geodesic aluminium dome yet to be built anywhere. This took two weeks to assemble and the whole project received very wide publicity in Russia.

Plating

The Russians have been carrying out extensive laboratory and pilot plant industrial tests on a bright, non-brittle acid copper plating solution[2]. B. P. Persiantseva, N. T. Kudriavtsev and B. M. Calb found that satisfactory coatings can be produced from the following solution :
250 gm. per l. $CuSO_4.5H_2O$, 50 gm. per l. H_2SO_4, 0.005 gm. per l. thiourea and 0.5 gm. per l. Na salt of 2.6 and 2.7 naphthalene disulphonic acid (to reduce brittleness caused by the thiourea).

The solution has been tested in the Russian printing industry for coppering print cylinders and was employed at a current density of 93 amp. per sq. ft., a temperature of 59-72°F. and with air agitation. The laboratory and pilot plant tests were so successful that a 4-month industrial trial was undertaken which showed that 0.0006-0.0008 in. could be deposited in 20-25 minutes. In fact, it was claimed that the general efficiency was increased so much that the number of copper plating tanks could be reduced from 16 to 4.

Still on the subject of plating, Domnikov[3] has given details of a new method of treating 400-type stainless steels prior to cadmium plating with a conventional cyanide solution. In essentials, this consists of alkali cleaning the stainless steel followed by treatment in hot (165°F.) 35 per cent sulphuric acid for 2 minutes, during which times a black film forms which can be easily wiped off. The parts are then given a nickel flash by plating for 1 minute in a solution of nickel chloride (8 oz. per gallon) and boric acid (5½ oz. per gallon) at 160°F. with a

(*Continued in page* 367)

ULTRASONIC CLEANING OF PRECISION INSTRUMENTS

IN the manufacture and assembly of precision gyro and optical instruments, very high standards of cleaning and also the maintenance of clean conditions by discouraging airborne contamination are particularly important. When facilities at the Barkingside, Essex, works of Kelvin and Hughes (Aviation) Ltd. for this type of work were considerably extended recently with the opening of new premises, a combination of ultrasonic cleaning techniques and air conditioning was chosen for this purpose, which has also had the effect of providing pleasant working conditions.

In these premises, an ultra-clean room containing the ultrasonic cleaning plant has been established which is maintained at a pressure slightly higher than atmospheric to prevent any dust contamination entering from outside and soiling the components after they have been brought to a very high degree of cleanliness. Critical work is carried out in pressurized cabinets, and entrance to this room and to a sub-clean room which contains pre-cleaning plant is through cloakrooms where outer clothing and shoes are removed and special protective clothing is put on, consisting of cotton overalls, close fitting cap and leather soled slippers. The floors are PVC covered and all working surfaces are covered in laminated plastics: the cleaning plant in these areas has been installed so that routine maintenance can be carried out from outside.

Fig. 1.—Loose dirt is removed by a perchlorethylene wash in the sub-clean area.

Fig. 2.—Specially designed baskets are used for holding small parts during ultrasonic cleaning to avoid screening.

Cleaning Operations

Pre-cleaning

Parts that are to be assembled in the clean room such as components of precision directional gyros for use in automatic pilots, pass through a cleaning stage in the sub-clean area so as to remove loose dirt. This stage, supplied by the Electro-Chemical Engineering Co. Ltd., of Woking, Surrey, consists of a perchlorethylene wash (Fig. 1) with filtration, fan extracted to atmosphere, after which the parts are taken through an air lock into the clean area.

Ultrasonic Cleaning

The cleaning plant in the clean area consists of a Personic-Vac ultrasonic unit and a drying compartment (Fig. 3) also supplied by the Electro-Chemical Engineering Co. Ltd. Perchlorethylene is again used as the solvent, and a 40-Kc/s generator excites a barium-titanate transducer in order to generate the ultrasonic energy that is employed for efficient cleaning. When small parts are to be cleaned, they are placed in a basket (Fig. 2) especially designed with as large a mesh as possible to avoid screening, while larger parts are placed on to a trivet inside the unit: the maximum size of component that can be treated in the tank is 9½ in. by 6 in. Vacuum is applied while the cleaning operation is carried out, so that any air in blind holes is removed, together with any entrapped air in the solvent, thus increasing the effectiveness of the cavitation: this tank is fan extracted to atmosphere. The time cycle of the cleaning operation is dependent on the shape and size of the parts being processed, and the perchlorethylene is filtered between operations by means of a bank of filters which remove particles down to 2μ in size.

Drying

Drying of cleaned parts may be by hot filtered air or by infra-red lamp, according to the type of component involved. The filtered air is heated by means of a 1200-w. heater and blown by a 1/5-h.p. fan on to the parts to be dried. In this stage, the closing of the lid of the equipment controls the drying operation. Completely clean and dry parts can now pass to the assembly stages.

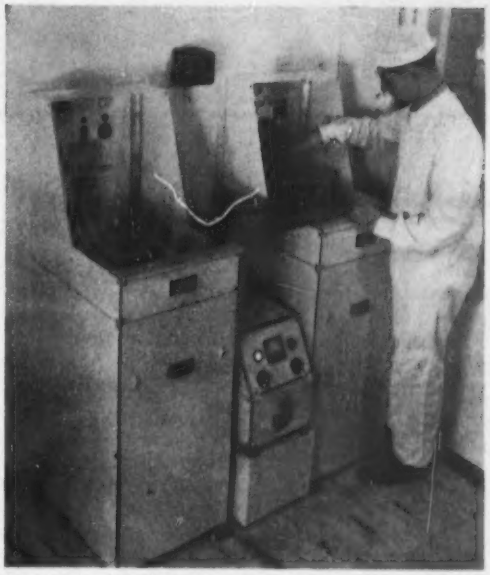


Fig. 3.—In the ultra-clean area parts are treated in the Personic-Vac ultrasonic cleaning unit seen on the left above; after cleaning they are dried in the right hand unit.

As a result of the construction of the clean room and the use of ultrasonic cleaning techniques, the reliability of the instruments produced has been considerably improved.

Overseas Review

(*Continued from page* 365)

*p*H of 4.3-4.7. They are then rinsed, dipped in 6 oz. per gallon sodium cyanide solution followed by plating in the cadmium cyanide solution and chromated.

Treatments for Steel

With the Packaging Convention which is being organized by the Association of British Chemical Manufacturers taking place this month, it is well worthwhile drawing attention to a recent article on surface treating and painting steel drums.[4] At the United States Steel Production Division of the United States Steel Corporation all body shells, heads and bottoms for steel drums are passed through a multiple stage automatic plant for cleaning, derusting and phosphating. The processing sequence consists of alkali cleaning, descaling, zinc phosphate treatment and a final chromic/phosphoric acid rinse. They find that by this means the inside of the drums when uncoated has adequate corrosion protection and when coated it has been properly prepared for the application of special high bake lining materials. It has also been announced[5] that the Ford Motor Company, U.S.A., will shortly be producing its own vinyl-coated automotive steel under a new Licence Agreement signed with the U.S. Rubber Company. Ford is using plastic coated steel in the 1959 Thunderbird and further applications are forecast as a result of this new licensing arrangement.

Non-Technical

Under an article entitled "28 Ways of Going out of Business—It is Easy, Just Follow these Directions"[6] method No. 3 is to do no research and development. *Verb. sap.*!

References

(1) *Light Metal Age*, June 1959, 18/19.
(2) *Metal Finishing*, August 1959, **66**, 67, 71.
(3) *Plating*, 1959, **46**, (5), 487-483.
(4) *Ind. Finishing*, June 1959, 8-10, 12.
(5) *Steel*, 1959, **145**, (4), 78.
(6) *Steel*, 1959, **145**, (6), 82-83.

FINISHING POST

A SELECTION OF READERS' VIEWS COMMENTS AND QUERIES ON METAL FINISHING SUBJECTS . . . . . .

Zinc Rich Primers

Dear Sir,

We have read with the greatest interest the article on "Zinc Coatings on Iron and Steel" by A. K. Parker, M.A., in collaboration with the Zinc Development Association but on coming to page 322, we note such a completely erroneous statement that we feel we should write to draw attention to this. Such a Journal as yours, enjoying the respect it does, cannot be expected to carry such inaccuracies unchallenged.

It is stated in the article that media in which zinc dust can be successfully incorporated have not been available until the last two decades, when in fact our late Managing Director, the late F. C. Dyche-Teague, B.Sc., F.R.I.C., had manufactured chlorinated rubber and had patents dated as early as September 1927 for chlorinated rubber, in which he successfully incorporated high concentrations of metallic zinc—thus successfully producing the first zinc rich primer.

It must be appreciated that a fully alkali resisting medium is essential for zinc rich paints, particularly when being considered for marine applications.

Much publicity was given in the middle '30s to zinc rich primers and several articles appeared in the daily press.

We are sure that you yourself as Editor, and no doubt your readers also, will be interested to have the facts in this matter.

Detel Products Ltd., South Ruislip, Middlesex.

Yours faithfully,
L. A. Johnson,
Director and Sales Manager.

. . . and Sherardized Coatings

Dear Sir.

With regard to the notes on sherardizing which were published in your September issue, we fear that we may have given a slightly wrong impression when we said (on page 321) that the tendency of a sherardized coating to appear brownish after a short period of service may make it unsuitable for parts which have an ornamental value. In fact, many pieces of ornamental ironwork made in an imitation Tudor style are sherardized and scratch-brushed to produce an armour-bright finish. This is decorative and has been regarded as a satisfactory finish over the period of at least 25 years during which it has been used.

Zinc Development Association, London, W.1.

Yours faithfully,
A. R. L. Chivers.

I.V.E. Silver Jubilee Conference

(*Continued from page* 354)

sand, under-baked cores and incorrect parting compounds, spalling of refractory linings of ladles, mould movement due to heavy lugs or bosses being affixed to thin walled castings, heavy addition of silicon or other alloying materials at the ladle, and finally, and probably most significant of all, hot sand.

Discussion

MR. E. R. EVANS said that the range of compositions suggested in the paper was unusual for this country.

Workers in the U.K. and in the United States had studied pinholes in iron castings and had attributed them to causes additional to those mentioned in the paper. Another point which Mr. Sanders had not mentioned was that in grey iron castings sub-surface pinholes could be caused by hydrogen coming from the mould. Something of the order of 0.1 per cent of aluminium could be responsible for pinholing in cast iron. Aluminium could come from ferro-silicon or the use of cylinder block scrap with aluminium pistons.

MR. SANDERS said that for satisfactory enamelling he tried to work with at least 3.50 per cent carbon and, if possible, 3.50 per cent silicon, giving a combined carbon/silicon content of over 6 per cent, after having read much literature from this country; in America they had written so little on this matter. He had been interested to obtain here some chemical analyses which provided confirmation, and he thanked his friends here for having allowed him to see how British people were doing the job.

MR. GORDON P. K. CHU considered there was some correlation between steel and cast iron in respect of their behaviour, but so far as the hydrogen defect was concerned, it was very unusual in steel. If a steel were very very bad, however, and if one made a cross-section, it was full of inclusions, pinholes and other defects, which could be detected by microscope, or even by the naked eye. There could be much hydrogen in the steel because so many artificial pores could be created during the process of hot or cold rolling, and those pores would serve as room for storing hydrogen.

SPRAYED METAL AND PLASTIC COATINGS

A Symposium

organized by the

METAL AND PLASTIC COATINGS ASSOCIATION

at the Charing Cross Hotel, London, on April 17th, 1959

(*Report concluded from page 312, September, 1959*)

EPOXY RESIN PAINTS

by H. B. FOOTNER, B.Sc., Ph.D., A.R.I.C.*

EPOXY resins are based essentially on epichlorhydrin and bisphenol, two simple molecules which are reacted together so that they link up and form long chains which constitute the molecules of the resin. Various grades of epoxy resins are manufactured ranging from liquids to solids depending on the number of constituent groups in the resin molecule. The different grades of "Epikote" resin are typical of these types.

It should be made clear that by themselves the epoxy resins do not form a surface coating as the individual chains have no elasticity. Their molecules do not normally react with one another and it is necessary to combine the long chains into a closely knit network of molecules which gives an elastic and continuous surface coating. These combining materials which react chemically with the epoxy molecules may be of several different types; they may be phenolic resins or the fatty acids from drying oils or such materials as the polyamines, and the properties of the finished coating will depend not only on the epoxy resin but also on the modifying resin which is used to complete the network. For instance, a phenolic resin will convey, or rather complete, the chemical resistance which the epoxy resin already possesses. The amount of expoxy resin in the epoxy phenolic type is about 60 to 70 per cent but in the case of epoxy esters (epoxy resin combined with drying oil acids) it is about 40 per cent. so that the properties of the film produced depend to a large extent on the properties of the oils. If, however, a polyamine is used then the resulting film has all the chemical resistance of the epoxy resin since the proportion of epoxy is about 90 to 95 per cent. of the total.

The chief properties conferred by epoxy resins are first-class resistance to chemicals, solvents and moisture together with good elasticity and remarkable hardness. It is necessary to supply the amine-cured epoxy paints as two separate components as the amine component reacts quickly on the epoxy resin. The amine-cured epoxy resin paints have the property of curing at ordinary temperatures and this discussion will be confined mainly to them, but it should be noted that some of the other types, such as the phenolic modified epoxy, require temperatures of about 200°C. to give the reaction which causes cross linking and produces a continuous film.

Amine-cured "Epikote" paints have found very considerable use in industry. They are hard, abrasion resistant and resistant to most chemicals, particularly alkalis, and also to petroleum products and many acids. They can be used for lining tanks carrying petroleum products, detergents and other chemicals, and in the United States they have also been used for lining pipelines. Their use in ocean-going petroleum tankers has been quite a spectacular success. These tankers may carry up to 30,000 tons of gasoline or crude petroleum and those carrying gasoline are very subject to corrosion. Many of the tanks on such ships are also used as ballast tanks on the return trips, so that they are also subject to salt water corrosion and to corrosion due to salt-laden atmosphere. In addition, the gasoline carried removes all traces of grease and oil from the surface so that the steel is freely exposed to the forces of corrosion. The use of amine-cured epoxy paints will enable tankers to be kept in the white oil (gasoline) trade for much longer periods.

As with other coatings, good preparation is essential for the application of the amine-cured epoxy coatings; the surface should be grit-blasted or, in some cases, pickled by a suitable process, before the coating is applied, the purpose being to give a good adhesion and to avoid moisture under the coating. It is also important that a certain minimum thickness should be applied. In good painting practice it is recognized nowadays that at least 5 mils of paint is necessary to give lasting protection. As amine-cured pigmented epoxy applied by brush gives a coating of

*Shell International Petroleum Co. Ltd.

approximately 1¼ mils ; four coats are regarded as the minimum, although in severe conditions it may be necessary to apply five or six coats.

A development in the use of amine-cured epoxy coatings which started in the United States three or four years ago is of considerable interest and is being rapidly followed up in the U.K. It is the combination of coal-tar pitch and amine-cured epoxy resin, which seems to provide the best properties of both materials. The straight epoxy coatings have rather doubtful resistance to pure water. Coal-tar pitch is very resistant in that regard, but is thermoplastic and flows at temperatures above 80°C. A properly formulated combination of the two has high chemical and water resistance and, at the same time, very good temperature resistance. For example this combination has been used in Venezuela to coat an underground pipeline which has to carry crude oil at a temperature of 260°F. Ordinary coal-tar pitch or asphalt coatings would not withstand such a temperature. The coating was applied by spray to give a dry film thickness of about 15 mils.

Coal-tar epoxy coatings have great possibilities for the lining of water tanks and for many other purposes. However, for the carriage of aviation gasoline, where complete purity of the spirit must be maintained, straight amine-cured epoxy finishes are still used, as there is the possibility that traces of coal-tar pitch might be dissolved. For all normal purposes, however, it may be assumed that the coal-tar pitch has been converted into an insoluble material.

Another interesting application of amine-cured epoxy finishes is in the treatment of concrete interceptors on chemical plants where all sorts of effluents may be present. A relatively thin lining of two coats, 2 to 3 mils thick, has given protection for several years.

The coating *in situ* of long pipelines with amine-cured epoxy coatings has been developed in the United States with spectacular results. A technique has been evolved whereby a length of line of some 30 miles may be treated as one unit and lined internally. The corroded line is first thoroughly cleaned by passing mechanical scrapers through it and by flushing with solvents or acids depending on the product previously carried. The interior of the pipe cannot, of course, be inspected visually and great care has to be taken to render it clean and dry. It is remarkable that sufficient cleanliness can be achieved by this method when one considers that normally grit-blasting is required before amine-cured epoxy finishes can be applied. Nevertheless, actual practice shows that it can be done.

When the line is clean a quantity of paint is introduced into the line between two plugs with differential air pressure so that the paint moves along leaving a thin coating on the interior by reason of a small clearance — up to 10 mils — between the rear plug and the line. When the flow reaches its destination, possibly 30 miles distant, the bulk of the paint has been deposited on the walls of the pipe. Such coatings have remained in good condition for as long as 7 years, as is shown by the fact that internal corrosion has been stopped and a very high pumping efficiency maintained. The amine-cured epoxy linings have been applied in oil, gas and water lines.

(A colour film, produced by the Shell Film Unit, was then shown. It illustrated the properties, manufacture, testing and uses of " Epikote " resins).

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Mr. MURPHY stated that his view was that the increased life of epoxy-lined pipelines might be due to the reduced coefficient of friction. He doubted whether the internal cleaning could ever be sufficient to permit the coating to give true freedom from corrosion. In any case, a pipeline failed, not from corrosion but mechanically. He thought that the epoxy coating had reduced the internal pressure and the mechanical forces but had not reduced the corrosion overall.

Dr. FOOTNER replied that if there was general corrosion however slight in a pipeline there would be an increase in friction and " C " value would be reduced. In fact the " C " value has been maintained at a very high figure for seven years in these internally coated lines and many inspections have shown that the coating remains in good condition.

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Regarding drum linings experience over 10 to 12 years showed that the pigmented epoxy-phenolic type gave the best results. This is more elastic than the unpigmented phenolic lacquer and can also be applied to a greater thickness. For optimum results the film thickness should be between 0.0009 and 0.0012 in. and the drum surface should be pre-treated either by chemical treatment or fine grit-blasting. He had found that drums lined in this way gave 5 or 6 years service in gasoline or

diesel fuels. As regards elasticity of the coating there was very local removal at sharp dents but adhesion remained good around the dent and there was no general detachment of the film. It could be stated with confidence that pigmented epoxy-phenolic coatings provided a satisfactory lining for aviation fuel drums provided sufficient care was taken in the pretreatment of the drum surface.

Dr. MASON (Ministry of Supply) asked Dr. Footner for his views on future developments in the corrosion protection of tankers' tanks, pipelines, and large storage tanks. He asked that because of an earlier question about drums, and they all realized that the protection of small containers in the petroleum industry was probably easier than the protection of large ones. His own view was that the protection of the tanks of large tankers was a difficulty that was largely unsolved.

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The lining of storage tanks did not present a great problem. A mild-steel storage tank had a normal life of about 50 or 60 years by which time it was likely, in any case, to be too small, or generally inefficient, or in the wrong position. Corrosion problems were very often due to wrong design, and bad preparation of the surface and application in the early stages. The surface coating materials now available were adequate for land storage tanks.

Corrosion problems occur in pipelines which are cleared with salt water. Trials are being made by inhibiting with sodium silicate and it has also been found that cement lining successfully prevents this trouble. Lining with epoxy resins if economical in application would be an alternative solution. Always in the background are pipes made from glass-reinforced thermosetting resins.

PLASTIC COATINGS

by N. VINSON*

THE coatings being considered in this lecture are, with certain exceptions, greater than 0.005-in. thick, and, in the majority of cases are 0.02-in. thick and above.

In protection, it is only the thickness of the coating that will give a high degree of durability. If this can be combined with a high corrosion resistance and good elasticity then the degree of protection is very high. Heavy plastic coatings have these properties.

The coatings to be dealt with have advantages over existing paint and metal finishes, although they are by no means a complete replacement of them. Certain plastics, when used as finishes, have all these desirable qualities of durability, abrasion resistance and adhesion. Indeed, they have one more — appearance. Few of them combine all these properties at an economical price, though, bo the selection of any one plastic it is possible to obtain some outstanding characteristics ; the other required characteristics follow, to a minor extent in its wake.

As regards heavy plastic coatings, the size of the articles to be treated is limited by stoving capacity which, to date, has been the primary restriction on growth. Certain plastics can be flame-sprayed, but this is a difficult process very dependant on the operators' skill. Coating and stoving are likely to remain, therefore, the major method of application.

*Managing Director, Durable Plastics, Ltd.

The plastics finding increasing application as attractive finishes are several, but grit- or shot-blasting is essential for a satisfactory surface finish.

Nylon finishes are generally applied at about 0.02-in. thick. If less is used, the object is defeated; if more is used, there is little added advantage to be gained. Depending on the intricacy of the article, the cost, at that thickness, probably works out, at the lowest level, at about 7s. per sq. ft. and, at the highest, at about £1.

Nylon's most remarkable property is its high abrasion resistance and flexibility. The finishes obtained from it are highly decorative and very pleasing, and one of the largest outlets for its use has been the textile industry, where its very high abrasion resistance enables it to be used on components handling yarns and threads. As it also has excellent non-toxic qualities it is also good for coatings in the foodstuffs industry, and it is particularly suitable for de-ionized water. Decoratively, it is largely replacing acid finishes on car steering-wheels, and that side is likely to grow very considerably. Its resistance to solvents, particularly trichlorethylene, makes it very suitable for jig coating in washing plants.

Two big-tonnage, heavy plastic coatings are low-density and high-density polythene. Everyone is familiar with low-density polythene, but it is, in some respects, limited in its usefulness as a surface coating as it is not totally satisfactory on sheet metal. This is partly due to a quality not

yet fully understood — environmental stress cracking set up by a working of the two different coefficients of expansion of the coating and the substrate metal. Other plastics have enough inherent flexibility to move together, but unless there is exceptional preparation, and unless adequate keying is obtained low density polythene coatings can give trouble after a time.

The principal application of low-density polythene in this country at the moment is as a coating for fabricated wire-work, ranging from machinery guards to refrigerator shields. Here, there is no danger of cracking and, at the same time, it is an extremely cheap process. On wirework, the cost

the Barkingside, Essex, works of Kelvin and Hughes (Aviation) Ltd. for this type of work were considerably extended recently with the opening of new premises, a combination of ultrasonic cleaning techniques and air conditioning was chosen for this purpose, which has also had the effect of providing pleasant working conditions.

In these premises, an ultra-clean room containing the ultrasonic cleaning plant has been established which is maintained at a pressure slightly higher than atmospheric to prevent any dust contamination entering from outside and soiling the components after they have been brought to a very high degree of cleanliness. Critical work is carried out in pressurized cabinets, and entrance to this room and to a sub-clean room which contains pre-cleaning

Fig. 1.—Loose dirt is removed by a perchlorethylene wash in the sub-clean area.

is very important, because, to some extent, the properties of the coating will depend on the plasticisers used, and the most corrosion resistant plasticisers are the most expensive. Cheaper plasticisers will be quite satisfactory in many conditions, but under severe corrosive conditions the life of the coating will be very limited, due to plasticiser extraction.

Polytetrafluoroethylene (P.T.F.E.) and polytrifluoromonochlorethylene (P.T.F.C.E.) are also used as coatings. P.T.F.E. has a very high corrosion resistance at temperatures up to 250°C., but is expensive to apply to a fabricated structure. P.T.F.E. coatings are sprayed at a rate of from

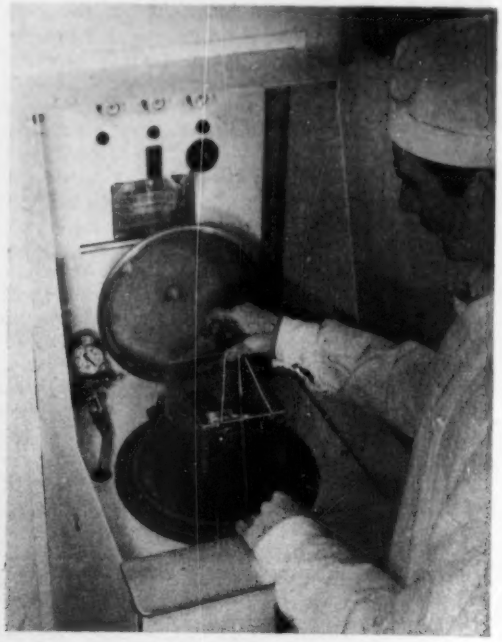
are covered in laminated plastics: the cleaning plant in these areas has been installed so that routine maintenance can be carried out from outside.

Cleaning Operations

Pre-cleaning

Parts that are to be assembled in the clean room such as components of precision directional gyros for use in automatic pilots, pass through a cleaning stage in the sub clean area so as to remove loose dirt. This stage, supplied by the Electro-Chemical Engineering Co. Ltd., of Woking, Surrey, consists of a perchlorethylene wash (Fig. 1) with filtration, fan extracted to atmosphere, after which the parts are taken through an air lock into the clean area.

Fig. 2.—Specially designed baskets are used for holding small parts during ultrasonic cleaning to avoid screening.



Developments in Vitreous Enamelling

(*Continued from page* 360)

being relieved as the temperature increases. The steel expands to relieve it and the enamel expands slowly at first and then exceeds the rate of the steel, actually building up to where the enamel is under tension. At the peak of the curve, viscosity of the enamel decreases to where the enamel becomes mobile and can no longer deform the iron, and the curve drops to the no-strain line. On cooling, the viscosity of the enamel again builds up and its contraction induces tension as the metal is not contracting as fast as the enamel. At the

inside the unit: the maximum size of component that can be treated in the tank is 9½ in. by 6 in. Vacuum is applied while the cleaning operation is carried out, so that any air in blind holes is removed, together with any entrapped air in the solvent, thus increasing the effectiveness of cavitation: this tank is fan extracted to atmosphere. The time cycle of the cleaning operation is dependent on the shape and size of the parts being processed, and the perchlorethylene is filtered between operations by means of a bank of filters which remove particles down to 2μ in size.

Drying of cleaned parts may be by hot filtered air or by infra-red lamp, according to the type of component involved. The filtered air is heated by means of a 1200-w. heater and blown by a ½-h.p. fan on to the parts to be dried. In this stage, the closing of the lid of the equipment controls the drying operation. Completely clean and dry parts can now pass to the assembly stages.

the industrial man can upgrade both. In a period such as the present the scientific education of the plant can get seriously out of date. The scientific man who, because of his associations with others in science, keeps up-to-date, can contribute something which industry needs and industry can contribute something to him so that he can better train those who will some day take over for us.

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(2) J. H. Healy and A. I. Andrews, "Cobalt Reduction Theory for Adherence of Sheet Iron Ground Coats," *J. Am. Ceram. Soc.*, **34**, 7, 207-214 (1951).
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Fig. 3.—*In the ultra-clean area parts are treated in the Personic-Vac ultrasonic cleaning unit seen on the left above; after cleaning they are dried in the right hand unit.*

As a result of the construction of the clean room and the use of ultrasonic cleaning techniques, the reliability of the instruments produced has been considerably improved.

Overseas Review

(*Continued from page* 365)

*p*H of 4.3-4.7. They are then rinsed, dipped in 6 oz. per gallon sodium cyanide solution followed by plating in the cadmium cyanide solution and chromated.

Treatments for Steel

With the Packaging Convention which is being organized by the Association of British Chemical Manufacturers taking place this month, it is well worthwhile drawing attention to a recent article on surface treating and painting steel drums.[4] At the United States Steel Production Division of the United States Steel Corporation all body shells, heads and bottoms for steel drums are passed through a multiple stage automatic plant for cleaning, derusting and phosphating. The processing sequence consists of alkali cleaning, descaling, zinc phosphate treatment and a final chromic/phosphoric acid rinse. They find that by this means the inside of the drums when uncoated has adequate corrosion protection and when coated it has been properly prepared for the application of special high bake lining materials. It has also been announced[5] that the Ford Motor Company, U.S.A., will shortly be producing its own vinyl-coated automotive steel under a new Licence Agreement signed with the U.S. Rubber Company. Ford is using plastic coated steel in the 1959 Thunderbird and further applications are forecast as a result of this new licensing arrangement.

Non-Technical

Under an article entitled "28 Ways of Going out of Business—It is Easy, Just Follow these Directions"[6] method No. 3 is to do no research and development. *Verb. sap.*!

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(1) *Light Metal Age*, June 1959, 18/19.
(2) *Metal Finishing*, August 1959, **66**, 67, 71.
(3) *Plating*, 1959, **46**, (5), 487-483.
(4) *Ind. Finishing*, June 1959, 8-10, 12.
(5) *Steel*, 1959, **145**, (4), 78.
(6) *Steel*, 1959, **145**, (6), 82-83.

FINISHING POST

A SELECTION OF READERS' VIEWS COMMENTS AND QUERIES ON METAL FINISHING SUBJECTS . . . . . .

Zinc Rich Primers

Dear Sir,

We have read with the greatest interest the article on "Zinc Coatings on Iron and Steel" by A. K. Parker, M.A., in collaboration with the Zinc Development Association but on coming to page 322, we note such a completely erroneous statement that we feel we should write to draw attention to this. Such a Journal as yours, enjoying the respect it does, cannot be expected to carry such inaccuracies unchallenged.

It is stated in the article that media in which zinc dust can be successfully incorporated have not been available until the last two decades, when in fact our late Managing Director, the late F. C. Dyche-Teague, B.Sc., F.R.I.C., had manufactured chlorinated rubber and had patents dated as early as September 1927 for chlorinated rubber, in which he successfully incorporated high concentrations of metallic zinc—thus successfully producing the first zinc rich primer.

It must be appreciated that a fully alkali resisting medium is essential for zinc rich paints, particularly when being considered for marine applications.

Much publicity was given in the middle '30s to zinc rich primers and several articles appeared in the daily press.

We are sure that you yourself as Editor, and no doubt your readers also, will be interested to have the facts in this matter.

Detel Products Ltd., South Ruislip, Middlesex.

Yours faithfully,
L. A. Johnson,
Director and Sales Manager.

. . . and Sherardized Coatings

Dear Sir.

With regard to the notes on sherardizing which were published in your September issue, we fear that we may have given a slightly wrong impression when we said (on page 321) that the tendency of a sherardized coating to appear brownish after a short period of service may make it unsuitable for parts which have an ornamental value. In fact, many pieces of ornamental ironwork made in an imitation Tudor style are sherardized and scratch-brushed to produce an armour-bright finish. This is decorative and has been regarded as a satisfactory finish over the period of at least 25 years during which it has been used.

Zinc Development Association, London, W.1.

Yours faithfully,
A. R. L. Chivers.

I.V.E. Silver Jubilee Conference

(*Continued from page* 354)

sand, under-baked cores and incorrect parting compounds, spalling of refractory linings of ladles, mould movement due to heavy lugs or bosses being affixed to thin walled castings, heavy addition of silicon or other alloying materials at the ladle, and finally, and probably most significant of all, hot sand.

Discussion

MR. E. R. EVANS said that the range of compositions suggested in the paper was unusual for this country.

Workers in the U.K. and in the United States had studied pinholes in iron castings and had attributed them to causes additional to those mentioned in the paper. Another point which Mr. Sanders had not mentioned was that in grey iron castings sub-surface pinholes could be caused by hydrogen coming from the mould. Something of the order of 0.1 per cent of aluminium could be responsible for pinholing in cast iron. Aluminium could come from ferro-silicon or the use of cylinder block scrap with aluminium pistons.

MR. SANDERS said that for satisfactory enamelling he tried to work with at least 3.50 per cent carbon and, if possible, 3.50 per cent silicon, giving a combined carbon/silicon content of over 6 per cent, after having read much literature from this country; in America they had written so little on this matter. He had been interested to obtain here some chemical analyses which provided confirmation, and he thanked his friends here for having allowed him to see how British people were doing the job.

MR. GORDON P. K. CHU considered there was some correlation between steel and cast iron in respect of their behaviour, but so far as the hydrogen defect was concerned, it was very unusual in steel. If a steel were very very bad, however, and if one made a cross-section, it was full of inclusions, pinholes and other defects, which could be detected by microscope, or even by the naked eye. There could be much hydrogen in the steel because so many artificial pores could be created during the process of hot or cold rolling, and those pores would serve as room for storing hydrogen.

SPRAYED METAL AND PLASTIC COATINGS

A Symposium

organized by the

METAL AND PLASTIC COATINGS ASSOCIATION
at the Charing Cross Hotel, London, on April 17th, 1959

(*Report concluded from page 312, September, 1959*)

EPOXY RESIN PAINTS

by H. B. FOOTNER, B.Sc., Ph.D., A.R.I.C.*

EPOXY resins are based essentially on epichlorhydrin and bisphenol, two simple molecules which are reacted together so that they link up and form long chains which constitute the molecules of the resin. Various grades of epoxy resins are manufactured ranging from liquids to solids depending on the number of constituent groups in the resin molecule. The different grades of "Epikote" resin are typical of these types.

It should be made clear that by themselves the epoxy resins do not form a surface coating as the individual chains have no elasticity. Their molecules do not normally react with one another and it is necessary to combine the long chains into a closely knit network of molecules which gives an elastic and continuous surface coating. These combining materials which react chemically with the epoxy molecules may be of several different types ; they may be phenolic resins or the fatty acids from drying oils or such materials as the polyamines, and the properties of the finished coating will depend not only on the epoxy resin but also on the modifying resin which is used to complete the network. For instance, a phenolic resin will convey, or rather complete, the chemical resistance which the epoxy resin already possesses. The amount of expoxy resin in the epoxy phenolic type is about 60 to 70 per cent but in the case of epoxy esters (epoxy resin combined with drying oil acids) it is about 40 per cent. so that the properties of the film produced depend to a large extent on the properties of the oils. If, however, a polyamine is used then the resulting film has all the chemical resistance of the epoxy resin since the proportion of epoxy is about 90 to 95 per cent. of the total.

The chief properties conferred by epoxy resins are first-class resistance to chemicals, solvents and moisture together with good elasticity and remarkable hardness. It is necessary to supply the amine-cured epoxy paints as two separate components as the amine component reacts quickly on the epoxy resin. The amine-cured epoxy resin paints have the property of curing at ordinary temperatures and this discussion will be confined mainly to them, but it should be noted that some of the other types, such as the phenolic modified epoxy, require temperatures of about 200°C. to give the reaction which causes cross linking and produces a continuous film.

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In protection, it is only the thickness of the coating that will give a high degree of durability. If this can be combined with a high corrosion resistance and good elasticity then the degree of protection is very high. Heavy plastic coatings have these properties.

The coatings to be dealt with have advantages over existing paint and metal finishes, although they are by no means a complete replacement of them. Certain plastics, when used as finishes, have all these desirable qualities of durability, abrasion resistance and adhesion. Indeed, they have one more — appearance. Few of them combine all these properties at an economical price, though, bo the selection of any one plastic it is possible to obtain some outstanding characteristics ; the other required characteristics follow, to a minor extent in its wake.

As regards heavy plastic coatings, the size of the articles to be treated is limited by stoving capacity which, to date, has been the primary restriction on growth. Certain plastics can be flame-sprayed, but this is a difficult process very dependant on the operators' skill. Coating and stoving are likely to remain, therefore, the major method of application.

*Managing Director, Durable Plastics, Ltd.

The plastics finding increasing application as attractive finishes are several, but grit- or shot-blasting is essential for a satisfactory surface finish.

Nylon finishes are generally applied at about 0.02-in. thick. If less is used, the object is defeated; if more is used, there is little added advantage to be gained. Depending on the intricacy of the article, the cost, at that thickness, probably works out, at the lowest level, at about 7s. per sq. ft. and, at the highest, at about £1.

Nylon's most remarkable property is its high abrasion resistance and flexibility. The finishes obtained from it are highly decorative and very pleasing, and one of the largest outlets for its use has been the textile industry, where its very high abrasion resistance enables it to be used on components handling yarns and threads. As it also has excellent non-toxic qualities it is also good for coatings in the foodstuffs industry, and it is particularly suitable for de-ionized water. Decoratively, it is largely replacing acid finishes on car steering-wheels, and that side is likely to grow very considerably. Its resistance to solvents, particularly trichlorethylene, makes it very suitable for jig coating in washing plants.

Two big-tonnage, heavy plastic coatings are low-density and high-density polythene. Everyone is familiar with low-density polythene, but it is, in some respects, limited in its usefulness as a surface coating as it is not totally satisfactory on sheet metal. This is partly due to a quality not

yet fully understood — environmental stress cracking set up by a working of the two different coefficients of expansion of the coating and the substrate metal. Other plastics have enough inherent flexibility to move together, but unless there is exceptional preparation, and unless adequate keying is obtained low density polythene coatings can give trouble after a time.

The principal application of low-density polythene in this country at the moment is as a coating for fabricated wire-work, ranging from machinery guards to refrigerator shields. Here, there is no danger of cracking and, at the same time, it is an extremely cheap process. On wirework, the cost can be as little as 1s. to 1s. 6d. a square foot, which is considerably cheaper than a 4-coat spray epoxy system, its nearest corrosion competitor.

High-density polythene, which is fairly new, commercially, in this field, has the advantage that it can be used at higher temperatures, and has higher abrasion resistance, but the surface finish obtainable is nowhere near as good. That rules out its domestic application, although it is finding increasing use on the industrial side, particularly as it is not so prone to stress cracking. Its main use is likely to be for steel pipe lining, particularly as larger processing plant is installed.

Polyvinylchloride — P.V.C. — has so far been the neglected cousin of the coatings family, primarily because, up to the last six months, there have not been the primers to give a satisfactory bond between it and the substrate metal. In the last six months, however, developments have been quite fantastic and a bond can now be obtained for P.V.C. on metals — and even noble metals, such as magnesium. For this reason P.V.C. will no doubt move fairly rapidly into the rubber lining field.

Its advantages are quite apparent, though its abrasion resistance is fractionally less ; nor has it quite such good resilience as natural and synthetic rubbers. Its corrosion resistance is higher, and it can be applied much more cheaply. To apply a $\frac{1}{8}$-in. deposit of rubber on a standard vat works out at probably 10s. to 15s. a square foot, and runs very much higher for intricate flanges and the like. The equivalent cost of P.V.C. is likely to be in the region of from 6s. to 10s. a square foot — a saving of some 35 per cent. On flanged work, the saving is very much greater because the P.V.C. can be applied by dipcoating. The advantages in using this process will be great, in that the deposit is applied uniformly throughout the article — in the case of a tank — and over the flanges, body and pipework.

Over the next few years, the author feels that there will be a rapid growth of P.V.C. coatings — but here a warning must be given. The composition of the P.V.C. into which the metal is dipped is very important, because, to some extent, the properties of the coating will depend on the plasticisers used, and the most corrosion resistant plasticisers are the most expensive. Cheaper plasticisers will be quite satisfactory in many conditions, but under severe corrosive conditions the life of the coating will be very limited, due to plasticiser extraction.

Polytetrafluoroethylene (P.T.F.E.) and polytrifluoromonochlorethylene (P.T.F.C.E.) are also used as coatings. P.T.F.E. has a very high corrosion resistance at temperatures up to 250°C., but is expensive to apply to a fabricated structure. P.T.F.E. coatings are sprayed at a rate of from 0.00075 to 0.001 in. at a time, but even when the coatings are built up to a thickness of 0.01-in. they are microporous, so that there is no long-term protection of the substrate metal. There is in fact no true sinter of the coating and this, to date, has limited its application to its other properties, the main one being a low coefficient of friction. There is, however, a very wide field for the application of P.T.F.E. using this property alone where suitably resistant substrate metal can be used — as a release coating for the rolls used in paper manufacture, for foodstuffs machinery handling sugar, chocolates and the like, or as a release coating for rubber moulds. It cannot be used as a dielectric at the present time. Rapid strides are being made, however, and there is a hope that non-porous P.T.F.E. coatings will be available in the near future.

P.T.F.C.E. has a really good metal bond, and there is complete sinter and flow of the material. It is, therefore, the only practical, totally anti-corrosive plastic which can be used at high temperatures of up to 180-220°C. Again, to achieve an adequate coating it is necessary to have a thickness of about 0.01-in. which makes it expensive, but there are many applications where it is the only answer so far. It has, in fact, solved many outstanding design problems, e.g., as an insulative and anti-corrosive coating for flow meters, bursting discs, vessels, etc.

Heavy plastic coatings are at present in their infancy and, generally speaking, are little known as a means of protection, but their use is becoming more and more widely adopted, as their individual and outstanding characteristics are recognized, and processing plant increases in size. By combining the properties of plastics with the strength of metals they offer to the designer, the best of both worlds.

Discussion

Dr. MASON (Ministry of Supply) expressed surprise that Mr. Vinson should have said that P.V.C. coatings had been neglected. Develop-

(*Continued in page* 373)

Developments in Vitreous Enamelling

(*Continued from page* 360)

being relieved as the temperature increases. The steel expands to relieve it and the enamel expands slowly at first and then exceeds the rate of the steel, actually building up to where the enamel is under tension. At the peak of the curve, viscosity of the enamel decreases to where the enamel becomes mobile and can no longer deform the iron, and the curve drops to the no-strain line. On cooling, the viscosity of the enamel again builds up and its contraction induces tension as the metal is not contracting as fast as the enamel. At the peak of the cooling curve the rate of contraction of the metal again exceeds that of the enamel and the tension in the latter is reduced to no strain and finally into compression which becomes greater as the specimen cools to room temperature.

Since the enamel at elevated temperatures is a viscous liquid, heat treatments (time at temperature) can greatly influence the final amount of compression. The thickness of the enamel coating, that of the metal, and the characteristics of the cover enamel all affect these stress-strain relationships. It is thus possible to do much more than control the thermal coefficient of expansion of the enamel in controlling the stress in the ware. Studies in different commercial furnaces demonstrate the feasibility of this practice.

In conclusion allow me to suggest that the enamelling industry throughout the world looks to its youth, their training, education and their teachers, as this is, in the present era of scientific expansion, the source material for our progress. Let not the promising young man of today have the difficulties of Joseph W. Mellor in getting his education. It is not only financial support that is important. It is the interest, counselling and broadening of the teacher who without it cannot pass it on to his students. The encouragement of research in the colleges and the co-operative effort on enamelling problems between the teacher and the industrial man can upgrade both. In a period such as the present the scientific education of the plant can get seriously out of date. The scientific man who, because of his associations with others in science, keeps up-to-date, can contribute something which industry needs and industry can contribute something to him so that he can better train those who will some day take over for us.

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Plastic Coatings

(*Continued from page* 372)

ment had been undertaken by at least two compsnies over a long period.

Mr. VINSON thought himself right in saying that P.V.C. coatings had been used primarily in the plating industry, where they were used very extensively. Outside that industry, however, they were still very little known as anti-corrosive coatings, as hitherto large capacity plant has not been available.

Relpying to other questions addressed to him, Mr. Vinson said that the cost of P.T.F.E. depended to some extent on the weight of the article being handled. At a rate of 0.0005-in. it worked out at about 6s. a square foot. To get a completely corrosion resistant coating of P.T.F.C.E. would cost anything from £7 to £10 per sq. ft.

Wire fabrications were normally made from more than one gauge of wire, so that the pick-up would be governed by the thermal capacity of the smallest gauge on which one would apply polythene coating to a minimum of 0.01-in. if real durability was required.

The most superior coating of nylon was No. 11, because of its very low water absorption. That was the only one available commercially. Another type had been found unsatisfactory because of embrittlement and long-term water absorption which led to substrate rust and other deterioration due to penetration.

FINISHING NEWS REVIEW

Engelhard linked with coatings process

METHODS for applying plastic coatings to hot metals, developed by Johannesburg engineer D. H. Brooks, have been patented throughout the world. The industrial possibilities of these new techniques are claimed to be enormous.

A company, backed by the Engelhard interests, has been formed to apply the techniques. A plant is being erected on a 13-acre site at Vereeniging—on the Vaal River, south of Johannesburg—and should be producing before the end of the year.

The Engelhard group is reported to be going ahead with the establishment of plants in the U.S.A. and other countries. The new methods are stated to allow perfectly bonded and smooth coatings to be applied to metals in a wide range of thicknesses and with well controlled accuracy.

Corrosion problems in the petroleum industry

Symposium in London

THE Institute of Petroleum and the Society of Chemical Industry are holding a joint symposium on the corrosion problems of the petroleum industry, to be held on November 26 and 27 in the Grand Council Chamber of the Federation of British Industries, 21 Tothill Street, London, S.W.1.

A reception will be held on November 25 from 6 to 8 p.m. for participants in the symposium and their guests (including ladies) at the Washington Hotel, Curzon Street, London, W.1.

Programme

The full programme arranged for the occasion is as follows :

Wednesday, November 25

At the Washington Hotel, Curzon Street, London, W.1.

6-8 p.m. Reception.

Thursday, November 26

At the Federation of British Industries, 21, Tothill Street, London, S.W.1.

9.30 a.m.-12.30 p.m. "Corrosion of production equipment and gathering lines and its prevention" by G. A. Lee and G. A. Haines (Kuwait Oil Co. Ltd.).

"Corrosion of marine structures and its prevention" by G. T. Colegate (Compania Shell de Venezuela).

2.30 p.m.-5.30 p.m. "Corrosion of tanker hulls and its prevention" by J. G. Robinson and K. Fleming (Shell Tankers Ltd.).

"Recent developments in the protection of pipelines and storage tanks" by H. B. Footner (Shell International Petroleum Company) and P. W. Heselgrave (Spencer and Partners).

Friday, November 27

9.30 a.m.-12.30 p.m. "Corrosion prevention in salt water cooling systems." Two papers presenting experience by (*a*) the plant manufacturer and (*b*) the user.

(*a*) P. T. Gilbert (Yorkshire Imperial Metals Ltd.) ;

(*b*) E. D. Dolan (British Petroleum Co. Ltd.).

2.30 p.m.-5.30 p.m. "Non-destructive testing" by L. Wilkinson and P. S. Cotten (Esso Petroleum Co. Ltd.).

"Developments in corrosion-resistant materials."

(*a*) "Metals" by G. L. Swales (Mond Nickel Co. Ltd.);

(*b*) "Non-metallic materials" by I. H. Thomas and T. S. McRoberts (Shell).

"Cut Borax Import Tax"

—urges V.E.D.C.

THE Vitreous Enamel Development Council, the Glass Federation, and other users have combined to prepare a claim for the reduction of import duty on borax. Statistics have been prepared that have formed the basis of discussions between the industries and the Board of Trade.

On the present price of £68 per ton, the import duty is 20 per cent. This is reflected in the price of a wide range of products, such as baths, cookers, sinks, refrigerators, pots and pans, architectural panels, and the output of the glass industry.

Little home production

Of the other chemicals used in the manufacture of vitreous enamels and glass, only zinc oxide carries a larger import duty than 10 per cent. But sufficient of this material is manufactured in this country to meet demands and there is a negligible import trade.

Duty defeats own ends

On the other hand, the borax produced in the U.K. is only a small proportion of the total demand, and almost all the material used had to be imported from abroad, mainly from the U.S.A.

It is obvious that, rather than forming a protective barrier, the high duty serves only to inflate the price of vitreous enamel and glass products.

Worse still, the high import duty is a handicap in the export development plans of the makers of holloware, who face increasingly strong competition abroad.

Exports affected

Some members of the Vitreous Enamel Development Council have already expressed concern at unfair overseas competition, and say that in West Africa the flood of cheaply produced holloware from Hong Kong has virtually eliminated what was once a thriving outlet for British goods.

Anything that the Board of Trade can do to help relieve the industry from what appears to be an unfair duty obviously should be done.

Rustproofing at Chrysler's plant

Seven-stage dip for car bodies

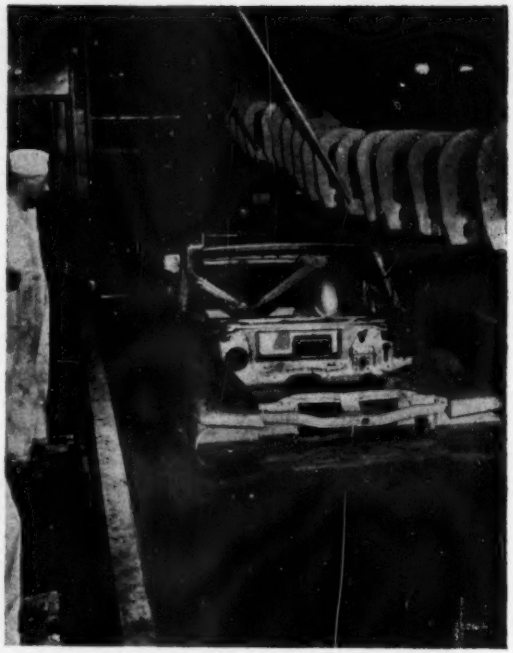
A NEW rustproofing system is being introduced by the Chrysler Corporation in Detroit aimed at giving longer life to their 1960 models, lower maintenance costs and better appearance.

The new system is an electronically-controlled method of cleaning and drying, heating and cooling, rinsing, priming and painting. It gives good protection to every part of the car body.

Each body is subjected to nine different temperature changes, three metal cleaning baths, seven anti-corrosion dips, seven spraying operations and seven external paint finishing operations.

Before introducing the new system, which is to be used at Chrysler's body plants in various parts of the United States, a quarter of a million miles of test driving on water-splashed chloride-treated roadways was carried out, and a total of four years laboratory testing was involved.

The anti-corrosion phase alone takes one hour and 45 minutes and is carried out on a roller-coaster conveyor encased in a tunnel more than 2,300 ft. long. Sixty cars per hour travel through the system and during peak production periods 16,800 gallons of primer are used each day.



The primer bath which coats the entire lower body of the car up to a height of 18 in.

Dipping and spraying

The rustproofing begins as soon as the steel arrives in coils and sheets from the mills. It is given three spray baths of caustic metal cleaner to remove all traces of oil and dirt. Then a special drawing compound is coated on the new steel on its way into the blanking and stamping machines. It then moves into the body building departments.

When the body of the car has been completed, it moves along the assembly line into the anti-corrosion tunnel. This is followed by a seven stage process as follows :—

For three minutes the body is immersed to a depth of 18 in. in a tank of alkaline cleaner while high-intensity alkaline sprays soak the upper part of the car. At this stage, the temperature of the liquid is approximately 180°F. Electronic controls start the assembly line conveyor and the car is lifted out of the bath for a 50-sec. drain-off period.

The body has a 30-second clear water rinse with the temperature at between 150 to 160°F.

The water is then cooled at least ten degrees and the car has a second rinse.

The car moves down to the lowest point of the conveyor for an immersion in 18 in. of phosphate coating while high-intensity sprays cover the upper portions. This operation is controlled by an electronic keyboard and takes one minute.

Next the car is taken out of the bath for a 50-second drainage followed by a 30-second cold water rinse.

For another 30 seconds the car has a chromic acid conditioner bath and spray at temperatures between 140 and 150°F. The car body is then drained, rinsed and air-dried at high pressure and continues through a drying oven for three minutes in a temperature of 225°F. To ensure complete drying, hot air jets are in use continuously before the body is cooled to room temperature.

This is the most important stage where the body undergoes an anti-corrosion bath with a grey-coloured water-reducible primer paint which is claimed by Chrysler engineers to be the finest rust-proof primer ever invented. The body is dipped into a 9,000 gallon tank to a depth of 18 inches and after soaking for one and a half minutes is lifted from the paint and moved into the drainage area.

Constant control is maintained during all stages of this procedure for all chemical treatments of the body. Chemical analysis is conducted at each stage of the anti-corrosion programme.

In addition, tests are conducted every hour on the caustic cleaning bath and spray to ensure maximum concentration of chemicals. Rinses are analysed and the phosphate bath and spray is chemically examined as is the chromic acid replenisher system.

Further rinses are checked twice daily. Chemists on the spot use phenolpthalein, sulphuric acid, sodium hydroxide, hydrochloric acid, potassium permanganate and other solution indicators to create chemical colour changes to reveal the quality control at all times.

Following this intense anti-corrosion dipping and spraying, the body undergoes seven stages of external finishing operations on the same conveyor belt. These include two coats of epoxy primer paint, oven baking at between 350 and 370°F wet sanding operations, first and second coats of stoving enamel, and then finally oven baking at 250°F.

(Diagram of line in following page)

Recent films

VEDC film on vitreous enamel

A TEN-MINUTE 16 mm. documentary film in black and white, entitled "It's Glass," has just been produced by the Vitreous Enamel Development Council. It deals with the methods of production of vitreous enamel, and its application in the home.

Briefly, the film shows the numerous household articles that are in every-day use that are finished in vitreous enamel. This is followed by scenes showing the production of frit, and how the domestic products are sprayed and fired with vitreous enamel, and finally completed for despatch.

Vitreous enamel's resistance to acids and alkalies, together with its many other properties such as heat resistance, hygiene and general durability are amply illustrated.

The Council feel that the film will go a long way to combat the ill-informed criticism of enamel, due mainly to the almost complete ignorance on the part of the general public—the housewife in particular—and some manufacturers, as to the meaning of the words "enamel finish."

The film is being made available to various educational authorities, film libraries, the women's institutes, and others, free of charge.

All enquiries for the film should be addressed to the general manager at the V.E.D.C. headquarters, 28, Welbeck Street, London, W.1.

A still from "Its Glass" shows the mixing of materials for frit

Industrial Electric Heating

THIS is, in effect, a film within a film.

A film director has been commissioned to make a film on industrial electric heating, a subject of which he is completely ignorant. He is seen making a first approach to Brewer, a manufacturer of electric heating equipment, who readily agrees to help him.

A quick tour of the works and a commentary by Brewer on equipment being built is sufficient to indicate the immense scope of the subject and it becomes apparent that the film will need some unifying theme.

The sight of a van in a loading bay suggests the motor car as this theme; that by showing some of the processes in the manufacture of this one product and its component parts the film will illustrate the various methods of electrically heating different materials in processes ranging from the preparation of the raw materials to the painting of the finished product.

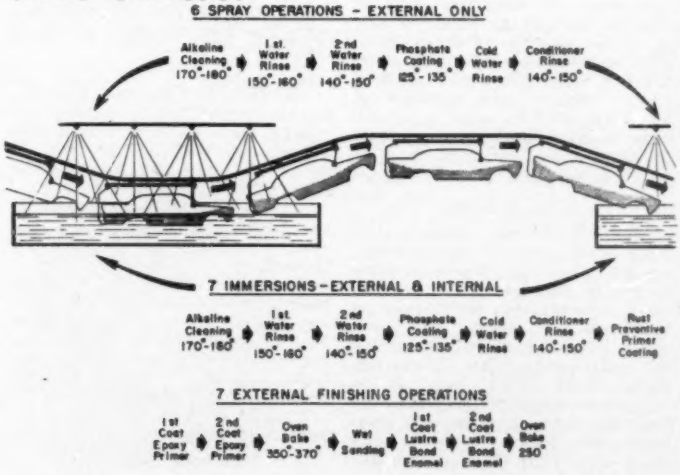
Brewer's commentary has rather bewildered our film director—"Induction! Dielectric!—I'm out of my depth"—and he accepts an invitation to join the firm's training class to learn something about the basic electric methods—arc heating—induction heating—dielectric heating—resistance heating.

In a subsequent meeting, Brewer suggests other firms who could provide shots for the film and goes through several case histories which make the film director, now better able to understand them, realise that there are few heating problems that electricity cannot solve, and few industries where productivity cannot be improved by using electroheat.

And so the film is made, not an exhaustive list of all possible applications of electric heating methods, nor a detailed picture of any one process, but a brief survey of the advantages claimed for applying electricity to many heating processes.

Diagram of Chrysler's Pretreatment Line

(*See story in preceding page*)



Technical & Industrial Appointments

The board of the **Imperial Aluminium Company Ltd.** has now been constituted as follows :—

From Imperial Chemical Industries Ltd.; Dr. James Taylor (chairman), Mr. Berkeley Villiers (managing director) and Mr. Michael Clapham.

From the Aluminum Co. of America; Mr. DuBose Avery and Mr. F. J. Resch.

I.C.I. will hold 51 per cent and Alcoa 49 per cent of the capital of Impalco. Control therefore remains in British hands.

Dr. James Taylor

Dr. James Taylor has been a member of the main board of Imperial Chemical Industries Ltd. since 1952. He is responsible for the metals and explosives activities of the company.

After studying at Durham, Paris and Utrecht universities, Dr. Taylor worked at Cavendish Laboratory, Cambridge, in 1927 under Sir J. J. Thomson and Lord Rutherford. In 1928 he joined the research department of I.C.I. Nobel Division as a physicist and in 1946 became research manager. The same year he was appointed a director of Nobel Division and in 1951 became joint managing director.

During the 1939-45 war Dr. Taylor was seconded to assist Sir Dennistoun Burney on work concerned with rockets and special projectiles. For this, he was subsequently awarded the M.B.E. He is chairman of Yorkshire Imperial Metals Ltd. and a director of African Explosives and Chemical Industries Ltd.

Berkeley Villiers

Mr. Berkeley Villiers has been commercial director of I.C.I. Metals Division since 1953. Mr. Villiers joined the I.C.I. sales organisation in 1934 and three years later was a departmental sales manager. In 1947 he was appointed regional sales manager of the metals department of I.C.I.'s southern region sales group and in 1952 became deputy regional manager, southern region. In 1953 Mr. Villiers joined the board of metals division as commercial director.

Michael Clapham

Mr. Michael Clapham, who is the third I.C.I. member of the board of directors of Impalco, has been joint managing director of I.C.I. Metals Division since October, 1952.

From Cambridge University, where he gained a Classical Tripos in 1933, Mr. Clapham joined the University Press, Cambridge, serving as an apprentice in all departments. After two years with Lund Humphries and Co. Ltd., the Bradford printers, he joined I.C.I. in its Metals Division secretarial department to assist in the running of the Kynoch Press. From 1940-44 he was manager of the Kynoch Press; in 1944 he became personnel manager of Metals Division and a year later was appointed personnel director.

Left: **Dr. Taylor**
(*Imperial Aluminium*)

Above: **G. L. Thompson**
(*Borax and Chemicals*)

Mr. Clapham is a director of Pyrotenax Ltd. and Yorkshire Imperial Metals Ltd. He is chairman of the Non-Ferrous Wrought Metals Export Group, vice-president of the British Non-Ferrous Metals Federation and a member of the committee appointed by the Ministry of Education to report on the youth service in England and Wales.

DuBose Avery

Mr. DuBose Avery has been elected a vice-president of Alcoa International Inc., the foreign marketing subsidiary of Aluminum Co. of America, and is the senior of the two Alcoa members of the board of directors of Imperial Aluminium Co. Ltd. Mr. Avery, who has been Alcoa's district sales manager in Pittsburgh, U.S.A., since 1957, will make his headquarters at a new office of Alcoa International which is to be opened in London.

Fred J. Resch

Mr. Fred J. Resch, formerly chief industrial engineer for the fabricating division of Alcoa's Tennessee operations, is the second of the two Alcoa directors who are to serve on the board of Impalco. Mr. Resch will be based at the aluminium rolling mill and extrusion plant at Waunarlwydd, South Wales, and will be concerned primarily with the manufacturing activities of the new company. Mr. Resch has been with Alcoa since 1934 when he was employed at the New Kensington, Pennsylvania, works. He served later in plant supervisory and industrial engineering assignments at the Cressona (Pennsylvania), Chicago and Lafayette (Indiana) operations before moving to the Alcoa Tennessee works in 1956.

* * *

Mr. W. J. Hatchley, a well-known personality in the boron products trade, who has been connected with the industry for 38 years, and has been managing director of **Borax and Chemicals Ltd.** since its inception, has relinquished executive duties but will remain a member of the board.

Mr. G. L. Thompson, also connected with the company for many years, has been appointed managing director.

* * *

Mr. John E. Coleman, M.I.E.E., has relinquished his directorship and major share-holdings in **Spesco Developments Ltd.,** which will in future be controlled by Imperial Chemical Industries.

Mr. Coleman became interested in the possibilities of polythene and allied plastic films for the packaging industry just after the war, when it was extremely difficult even to obtain experimental samples. This pioneering work and financial support from Mr. Coleman enabled Spesco Developments Ltd. to become one of the largest suppliers of plastic film for packaging containers in Britain.

Mr. Coleman has relinquished his interest to devote his full attention

(*Continued in page* 379)

Aluminium deposits as coating on metals

N.R.C. development for preventing rust and corrosion to be made available

A NEW process for preventing rust and corrosion on steel and other metals by the application of a "thick" aluminium skin, developed by the United States' National Research Corporation, Cambridge, Mass., was reported recently by Aluminium News of Montreal, Canada, who quoted from the American journal, Business Week.

According to the report, the technique is similar to the vacuum coating method now used to give a purely decorative finish to such articles as mirrors and plastic toys, a process in which aluminium is boiled in a vacuum, and the resulting aluminium vapour is condensed on the part to be coated.

Four thou. aluminium coatings

The N.R.C. development is claimed to considerably increase the thickness of the pure aluminium coating obtainable by this method, and a figure as high as 0.004 in. is quoted. The thicker coatings are also said to be adherent, ductile and non-porous, and have been successfully used on a variety of materials, such as high tensile steel, cold rolled steel, aluminium die castings, forgings, titanium, magnesium and cast iron. The method can be used for the semi-continuous and continuous processing of rolls of flexible material such as steel strip, or for batch production of individual objects.

Importance to car manufacturers

In addition to the excellent corrosion resistance possessed by aluminium, the coatings lend themselves to the anodizing process and to dyeing.

For the car industry, the possibilities offered by the process could be important. Apart from being able to colour-match car accessories, manufacturers could conceivably use the thicker coatings of aluminium in three ways: (a) as an alternative to dipping body sheet steel in molten metal; (b) as a corrosion protective coating for aluminium die castings and forgings of particular alloys; and (c) as a protective coating for cheaper stamped or pressed steel parts. Presumably, the comparable cost of coating with aluminium might also make the process an alternative to chrome plating for external car trims.

. . . And to aircraft industry

If the method is potentially important to the car industry, it is doubly so to manufacturers of aircraft components. Many high tensile components at present used are protected from corrosion by either a dip process to deposit an aluminium coating, or by an electroplating process to deposit cadmium. The temperatures involved in the former, and the risk of causing hydrogen embrittlement by using the latter, are disadvantages that could weigh in favour of deposition of aluminium by the vacuum method. It is said that N.R.C.'s preliminary experiments indicate that the new coatings are suitable for aircraft and some missile applications where a high level of corrosion resistance is required at high temperatures.

In a series of bend tests, several samples of $\frac{1}{16}$-in. mild steel sheet coated with approximately 0.0015 in. of aluminium, have been bent 180 deg. over a radius of $\frac{1}{16}$-in. dia. When magnified, it is claimed the coatings revealed no cracking or lifting after either tension or compression.

Commercial process available

It is proposed to develop the thick-film vacuum metallizing process on a commercial scale, under licence. N.R.C.'s manufacturing subsidiary, NRC Equipment Corpn., will design manufacture and install the required equipment for use with the process.

Technical & Industrial Appointments

(*Continued from preceding page*)

to the **Gresham Lion Group** in the field of automation, and automatic process controls in particular.

* * *

At a recent meeting of the board of **Aluminium Laboratories Ltd.** in Montreal, Dr. R. T. Parker was elected a director and vice president of the company. Dr. Parker recently took charge of the Banbury and Geneva offices of the company in succession to Mr. R. D. Hamer.

At the same meeting, Dr. D. E. Thomas, head of the department of patents and contracts, was appointed an assistant secretary.

* * *

Birlec Ltd., Erdington, have established a Midland area sales office, with Mr. H. J. Podmore as manager. The new office is at the company's main premises in Tyburn Road, Birmingham 24.

Mr. Podmore joined Birlec in 1955 as sales manager of the dryer and gas plant division.

* * *

Mr. N. R. Kirkby has been appointed general sales manager of **Croda Ltd.,** the chemical, oil and paint manufacturers. He will be making a tour of Croda's Continental associates next month.

Mr. Kirkby, who joined Croda 20 years ago as a laboratory assistant, has for the past few years been the company's chief technical representative in the Sheffield area. His new post is to take charge of Croda's entire sales organisation and to promote the sales of their many products throughout the world.

Mr. R. J. Seddon will be succeeding Mr. Kirkby as representative in the Sheffield area.

N. R. Kirkby
(*Croda Ltd*)

Finishing Practice and Technology . . . C & G Courses at Boro' Polytechnic

COURSES leading to the City and Guilds of London Institute examinations entitled "Metal Finishing Practice Certificate" and "Metal Finishing Technology," are being held at the Borough Polytechnic, Borough Road, London, S.E.1.

The course on technology has recently been completely reorganised by the advisory committee in metal finishing of the C. and G. Institute, and now occupies an important place in the system of educational qualifications in metal finishing.

Metallurgical control in manufacture

Compressor makers open new laboratories

AT the headquarters of the Holman Group in Camborne, Cornwall, a new metallurgical control and heat treatment department has been built and equipped.

The up-to-date department will also be used by the other members of the Group: Maxam Power Ltd., Goodyear Pumps Ltd., and Dustuctor Co. Ltd. This centralisation of metallurgical research and control and heat treatment is said to have already resulted in greatly increased efficiency and a significant speed-up in production.

The department, with a floor area of 17,000 sq. ft., contains metallurgical, physical and chemical laboratories, and heat-treatment sections.

The various metals used in the manufacture of Holman Group products are analysed and routine metallographic examinations of the heat treatment processes carried out in the metallurgical department.

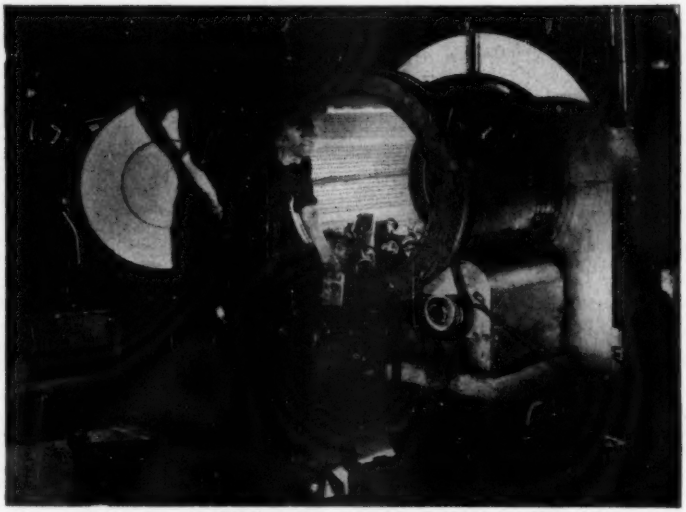
Among up-to-date equipment used in the metallographic and physical laboratory and the chemical laboratory are various hardness testing machines, a Reichert "M.E.F." camera microscope, a Watson "Holophot" microscope, metallographic mounting and polishing machines and a Dennison tensile testing machine.

The adjoining heat treatment Department is divided into three sections—a high-speed tool steel and piston heat treatment section, a general heat treatment section and an inspection section. Heat treatment of high speed steels, highly alloyed steels and tool steels is carried out by Birlec, G.E.C., and E.F.C.O. batch-type furnaces, Birlec forced air circulating tempering furnaces, Birlec-Cassel salt bath furnaces, and Shorterizing equipment. Also included in this section are machines for vapour-blasting, shot-peening and shot-blasting.

Rotary shot blasting

In the general section, heat treatment of constructional case-hardening steel is carried out by operations involving annealing, normalising, carburizing, hardening and tempering. Equipment in this section includes Wild-Barfield drip-feed gas carburizers, E.F.C.O. salt bath furnaces, Birlec 110 kW pack carburizing furnaces and various types of oil quenching machinery. Spenstead rotary shot blast equipment is used for general shot blasting operations.

Hardness and other tests are carried out in the inspection section, through which all finished heat-treated work passes. Hardness testing equipment used includes Brinell, Rockwell, Vickers and Shore Scleroscopes.



The rotary shot blast machine cleans these rock drill components

S.C.I. Corrosion Group Exhibition at Battersea

The corrosion group of the Society of Chemical Industry will be holding their conversazione and exhibition once again next year on January 21 at the Battersea College of Technology, London. S.W.11. The exhibition will remain open for public viewing on the following day also.

Intending exhibitors are requested to give preliminary notice as soon as possible to Dr. E. C. Potter, Grove Road Power Station, Lodge Road, London, N.W.8. (Telephone: Cunningham 7515).

It is hoped that this time special emphasis will be given to exhibits relating to marine corrosion, although offers of material illustrating the progress of research and development in any aspect of metallic corrosion and its prevention will be welcome.

Electrical Show at Earls Court

AROUND 450 manufacturers will show their products at the Electrical Engineers Exhibition to be held at Earls Court from April 5-9.

The number of first floor stand sites have been increased, and the show will have nearly five miles of stand frontages.

The "Marine Electrics" feature will occupy 5,000 sq. ft. on the first floor. This should prove to be a topical feature as the exhibition period will be near the launching date of the Canberra, the largest passenger vessel to be built in the United Kingdom since the two Queens.

This P. & O. ship will be the largest British passenger ship to be powered entirely by A.C. current, and will include much specially designed electrical equipment. It will be propelled by 85,000 S.H.P. twin-screw turbo electric machinery, having 4 turbo alternators giving an output of six megawatts.

In addition to new developments displayed within the exhibition feature, many of the stands will include marine electrical equipment.

Marston to make Hudson fans

"Marex" trade name for U.S. industrial products

A SUBSIDIARY company of Imperial Chemical Industries Ltd., Marston Excelsior Ltd., have acquired from the Hudson Engineering Corpn. of Houston, Texas, the sole right to manufacture Hudson hollow-blade plastic industrial fans in the United Kingdom. The fans will be sold under the trade name "Marex."

Initially, the standard range will consist of four-bladed fans ranging from 6 to 14 ft. in dia. in stages of 2 ft. A set of hollow plastic blades may be fitted to two types of hub, either an auto-variable hub that uses a pneumatically activated diaphragm to alter the angle of pitch while the fan is in motion, or a hub with a pitch that can be adjusted only when the fan is stopped. On both types, the angle of pitch can be varied between −15 deg. and +30 deg.

The advantages claimed for these fans over conventional wooden and metal types lie in the materials, method of construction and the aerofoil shape. Blades are made of woven glass cloth and pigmented epoxy resin, laminated as a one-piece moulding, and self-coloured.

The blades being hollow are extremely light, and a set for a ten ft. fan weighs only 58 lbs. Those of the same size are readily interchangeable as all blades are balanced at the works to a standard value.

THE silver medal of the Midland section of the Junior Institution of Engineers has been awarded to Mr. J. F. Elsworth of West Bromwich for his paper "Factory heating and ventilation."

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A SPECIALIZED press and public relations service at home and overseas for the metal and wood finishing industries is being offered by W.P.R. Ltd., 184, Fleet Street, London, E.C.4. Principal is Dr. W. F. Coxon, M.Sc., F.R.I.C., F.I.M.

MEETINGS OF THE MONTH

October 19

Institute of Metal Finishing (London Branch). "High temperature anodizing," by A. W. Brace and R. E. M. Polfreman, at the Northampton Polytechnic, St. John Street, London, E.C.1. 6.15 p.m.

October 22

Society of Chemical Industry. (Oil and Fats Group joint meeting with the Oil and Colour Chemists Association). "Polymers and plasticizers derived from fats," by Waldo C. Ault, at Manson House, 26 Portland Place, London, W.1. 7 p.m.

October 29

Society of Instrument Technology (Grangemouth Section). "Electrode problems in plant pH measurement," by Dr. G. Mattock, in the Ellwyn Restaurant, Newlands Road, Grangemouth. 7 p.m.

October 30

Institute of Metal Finishing (Sheffield and North East Branch). Open evening discussion, chairman C. Wharrad, at the Grand Hotel, Sheffield. 7 p.m.

November 5

Society of Chemical Industry (Corrosion Group). "Corrosion factors affecting the choice of stainless steels for chemical plant," by H. T. Shirley, at the Gas Showrooms, Shakespeare Street, Nottingham. 7.30 p.m.

November 6

Society of Instrument Technology (Fawley Section). "The safe use of electricity," by S. J. Emerson, at the Administration Building, Esso Refinery, Fawley. 5.30 p.m.

November 11

Institution of Plant Engineers (Western Branch). "Developments in the gas industry," by W. A. Simmonds (The Gas Council), at the Grand Hotel, Broad Street, Bristol. 7.15 p.m.

November 11

Institute of Metal Finishing (Organic Finishing Group). "Pretreatment methods and choice for organic finishing," by D. H. Lloyd and N. J. Heslop, at the British Institute of Management, 80, Fetter Lane, London, E.C.4. 6.30 p.m.

November 19

Institute of Vitreous Enamellers (Midland Section). "Wet process enamelling of cast iron." by E. R. Evans, at the Birmingham Exchange, and Engineering Centre, Stephenson Place, Birmingham. 7.30 p.m.

November 27

Institution of Plant Engineers (Birmingham Branch). "Instrumentation in industry with particular reference to control of temperature, pressure flow, weight, etc.," by L. F. Cohen (Elliot Bros. Ltd.), at the Imperial Hotel, Temple Street, Birmingham. 7.30 p.m.

Electropol Chief Makes U.S. Tour

A DIRECTOR of Electropol Processing Ltd., Farnham, Surrey, Mr. P. Allan Charlesworth returned to the U.K. earlier this month after

P. A. Charlesworth

a business tour of the United States that took him to eight major industrial centres. Mr. Charlesworth, the inventor of the firm's electrolytic process for the polishing of stainless steel, is also the managing director of the patent holding company.

The three week trip was concerned with reciprocal sales promotion and the exchange of technical information, and took him to such undertakings as the Republic Steel Corpn., the Eastman Kodak Co., and the Battelle Development Corpn.

ENDURION PROCESS BY PYRENE

THE Metal Finishing Division of The Pyrene Co. Ltd., say that by arrangement with B.B. Chemical Co. Ltd. (the "Bostik" people), they are now marketing the Endurion process as an addition to their established range of Parkerizing rust-proofing finishes for the treatment of ferrous metals.

The process is a simple immersion treatment used in conjunction with Parkerizing zinc phosphate systems. The coating produced, light grey in colour, can be waxed, oiled or painted. Optionally, the natural grey Endurion coating can be coloured by dyeing followed by waxing, oiling or lacquering.

The process, developed in the United States, is patented both there and in the United Kingdom, and is used widely for increasing the corrosion resistance of a comprehensive range of ferrous components. A leaflet describing the process can be obtained from Pyrene.

NEW COMPANIES

"Ltd" is understood also "Private Co." Figures = Capital, Names = Directors, all unless otherwise indicated.

Paniquil (Sales), Imperial House, Dominion Street, E.C.2. July 31. £10,000. To carry on bus. of manufacturers of and dealers in padded and quilted plastic panels produced by a welding or other process, etc. Gerald Ambrose, Dennis S. Warshaw.

Fan Systems (London), 211 Deansgate, Manchester, 3. July 31. £1,000. To carry on bus. of heating, ventilating and air conditioning engineers, etc. James R. Murphy, Vere E. Hood, Alfred C. Simkins.

Jaywood Electro Plating, 187 High Street, Brentford, Middx. August 6. £1,000. John H. Wood, Enid D. Wood.

Ian Summers, Newstet Road, Kirkby Industrial Estate, Liverpool. August 7. £100. To carry on bus. of manufacturers of and dealers in machinery for the chemical industries etc. Walter H. J. Pickavance.

P. G. Engineering. August 19. £100,000. To carry on bus. of designers, manufacturers and constructors of plant and equipment for the production and treatment of chemicals, gases, oils, metals, minerals, etc. Charles Robson, Newstead, 237 Oxbridge Lane, Stockton-on-Tees ; William R. Brown, Cuthbert E. Wrangham, Robert W. Rutherford, Peter M. K. Emglin, Charles Ingram, Thomas H. Riley.

Semiconductor Thermoelements, Room 4, 4th floor, 93/97 Regent Street, W.1. August 10. £100. To carry on bus. of manufacturers of and dealers in and licensees of and general research establishment for pure elements and chemical compounds, etc. Adam Gelbtuch.

Conveyor Installations, The Power House, Formby. August 12. £1,000. To carry on bus. of manufacturers of and dealers in material handling equipment, etc. W. H. J. Pickavance.

McKee Head Wrightson. August 18. £100. To carry on bus. of inventing, designing, engineering and constructing plant and equipment for the production of substances to be marketed as chemical products for the use in the petroleum or chemical industries, etc. Directors not named.

Anomel Finishes, 103 Gt. Portland Street, W.1. August 19. £100. To carry on bus. of electro, chromium, silver and nickel platers, etc. Frederick C. Gale, Charles J. Morgan.

Fan Systems (Huddersfield), Apsley works, St. Andrews Road, Huddersfield. August 25. £2,000. To carry on bus. of manufacturers of and dealers in fans, air purification apparatus, etc. Jas. R. Murphy, Leslie M. Brook, Alfred C. Simkins, Wm. Vaudrey, Richard M. Brook, Gerald F. Brook.

Metallic Coatings, Small Lane, Mobberley, Knutsford, Ches. August 26. £1,000. Peter Waterhouse, Geoffrey Ainley, Michael Waterhouse, Edward Dillon, Oliver D. B. Coe.

Montford Metal Finishing, 360, Kennington Road, S.E.11. August 26. £100. George Korosi, Dorothy R. Barton.

Butterworths (Regia), Regia Works, Albert Street, Ramsgate. August 28. £2,000. To carry on bus. of electro, nickel and chromium platers, etc. Henry F. Butterworth, Peter J. Butterworth.

Anodising Research & Development Organisation, 115-120, Abbey House, Westminster, S.W.1. August 28. £100. Wm. A. Prestage, Thomas O. D. Craig.

Williams Ansbacher. August 31. £20,000. To carry on bus. of manufacturers of and dealers in aniline dies, organic chemical pigments, etc. Directors not named.

Lark Bros. (Polishers), 77 Portland Place, W.1. August 31. £100. To carry on bus. of general engineers, metal polishers, etc. Sidney E. Lark, Leonard G. Lark, Sidney J. W. Holt.

Metroform, 29, Museum Street, W.C.1. August 31. £100. To carry on bus. of manufacturers of and dealers in vacuum forming of plastic film, etc. Harry Alexander, Mark, S. Myers.

From the Register compiled by Jordan & Sons Ltd. 16 Chancery Lane, London, W.C.2.

E.C.G.D. COVER

THE Exports Credits Guarantee Department says it is prepared to insure capital goods business with Yugoslavia on terms of credit extending to five years from date of shipment. Previously, the limit was three years from shipment. ECGD liability under this new cover will be 75 per cent of loss for all risks covered.

The relaxation is intended to enable U.K. manufacturers of capital equipment to continue to compete for business in Yugoslavia.

Silver Jubilee for British Titan

THIS year is the silver jubilee of the first production of titanium dioxide by British Titan Products Co. Ltd., although the firm was incorporated in 1930. In a recent ceremony to commemorate the occasion, chairman Mr. G. H. Beeby

G. H. Beeby

presented a wallet to all the firm's employees, and reviewed the spectacular growth of the company.

In the twenty-five years since British Titan first started production, the amount has grown from 2,000 tons of pigment a year to nearly 90,000 tons from the English factories alone, and the firm has plants in four major Commonwealth countries.

Further expansion planned

All told, expansion plans total almost £14 million. In the June issue of this journal, the company's recently completed extension to their Grimsby plant was described, an extension that increased the capacity to 70,000 tons per annum of titanium pigment. A new development that will include a comprehensive modernisation scheme for the whole plant is planned to increase production still further to a point where the combined production of both the Grimsby and Billingham plant will total a record 105,000 tons per annum.

Canadian venture

In addition, expansion plans are in hand for the firm's associates in Australia, India, and South Africa; B.T.P. has decided to establish a company in Canada, and will erect a plant there at a cost of £6 million.

Outside the U.S.A., British Titan Products is the world's largest producer of titanium pigments. Mr. Beeby assured the company's employees that the management have every intention of retaining this position.

Vitreous Enamel Council's A.G.M.

THE second annual general meeting of the Vitreous Enamel Development Council was held at the council's headquarters, 28 Welbeck Street, London, W.1. on September 30.

In his report, chairman Mr. S. W. Vickery commented generally on the work done during the past year. In that time, the London headquarters had been established and the staff increased considerably. Membership had also increased by more than 25 per cent and now includes foreign members in Eire, Italy, Finland, Holland and South Africa. He said that the Council was now generally recognised as the voice of the enamelling industry and was dealing directly with Government departments and other trade and professional bodies.

In reports presented by the various divisional chairmen, stress was laid on increased consumer protection and education. A warrant for vitreous enamel hollow-ware, guaranteeing replacement should any fault appear in 12 months after purchase, had done much to regain the public's confidence in these products. Its introduction and the attendant advertising campaign produced immediate results and in some cases sales were increased by up to 30 per cent.

Electric power in finishing

ELECTRICITY is the only form of energy which does not require oxygen in some form or another for its conversion into heat, and does not produce any products of combustion. For these reasons, it was playing an important part in industries where it was desirable to avoid contamination of the product being heated.

Mr. J. T. Sharples, B.Sc.Tech., A.M.I.E.E., industrial heating specialist of the Electrical Development Association, speaking on "Industrial Electric Heating" during a fortnight's course on electro-technology, for engineers of the National Industrial Fuel Efficiency Service, held at the Central Electricity Generating Board School, Buxton, recently, cited examples of this.

The vitreous enamelling process was one in which the quality of the product was playing an increasingly important part when it came to deciding what method of heating was to be employed in firing the enamel frit, he said.

There was little doubt that, at present, an oil-fired, or even a gas-fired furnace could be operated more cheaply than an equivalent electric furnace if one considered only the fuel cost. But fuel fired furnaces incorporated a thick refractory muffle to keep the products of combustion away from the enamel, which would be affected by them.

Muffle eliminated

A compromise had to be made between the thickness of the muffle and the size and cost of the furnace, and in practice no muffle could be guaranteed to give 100 per cent protection against contamination. A case could be quoted where a manufacturer of kitchen ranges using a gas-fired furnace had to have a close inspection process for enamelled components so that reasonable colour matching could be effected in the final assembly.

Mr. Sharples mentioned the case of a metal working factory which was considering the installation of a small electric infra-red oven for paint stoving, but was deterred by a consideration of its running cost.

As the factory demand was occasioned mainly by some air compressors, presses and the like, and occurred when these were first switched on in the morning, it was pointed out that it would be a simple matter for this demand to take place before switching on the infra-red oven, which would of course be ready for use within a few minutes.

HYDRA-SPRAY AGREEMENT FOR BULLOWS

AN agreement with the Gray Co. Inc. of Minneapolis, U.S.A., has been made by Alfred Bullows and Sons Ltd., Long Street, Walsall, giving them sole distribution rights in the U.K. for the complete range of "Graco" industrial equipment.

The Graco range is already well-known in this country, particularly in the automobile industry. It includes "Hydra-Spray" airless spray painting system, heavy material spray and extrusion equipment, and fluid transfer units of all types.

The Graco pumps are air-operated models suitable for handling all types of fluids and semi-fluids, from inks and paints to heavy mastics and putties.

The illustration shows a specially fitted Bullows vehicle to tour on a countrywide programme of demonstrations. These demonstrations are carried out on customers premises using their own materials, demonstrating the equipment under normal working conditions.

Bullows have created a Graco Division staffed by widely experienced personnel who will gladly provide further details and literature relative to this range of equipment and will arrange demonstrations where required.

Trade and Technical Publications

A leaflet issued by Precision Components (Barnet) Ltd., 13, Byng Road, Barnet, Herts., describes the range of polythene containers made under the trade name "Kabi."

The containers are moulded in either rigid or flexible polythene, and designed in a useful variety of shapes and sizes.

The low-density polythene is resistant to practically all inorganic chemicals, including acids, alkalis and salt solutions. The main exceptions are powerful oxydising fluids such as strong nitric acid. It is also resistant to corrosion, water and water vapours, and is unaffected by frost. Rigid high-density polythene has all the qualities of low-density polythene, but offers greater rigidity, and it can be sterilised by boiling.

* * *

A recent issue of "Finishing Facts," published by the Paints Division of Imperial Chemical Industries Ltd., Slough, Bucks., contains an article describing the Ransburg plant in use at Burnley Components Co., of Burnley, Lancs. All steel parts are degreased in trichlorethylene vapour and immersed in I.C.I. "Deoxidine" 170, afterwards being phosphated by the I.C.I. "Granodine" M process to provide a paint receptive surface. After rinsing in a slightly acidified hot water tank, components are force dried by infra-red heating panels before proceeding to the painting section. In the Ransburg plant, all wash-boilers and washing machines made by the company are given a wet-on-wet double coating of "Dulux" stoving epoxy enamel F.683. All finished components are stoved in a Ballard camel-back oven at 320° F.

Other articles are Part I of "The Stoving of Paints" by Charles Lighton of the Paint Division's technical service laboratory, and "The Vespa Story," describing the finishing line for motor scooters produced by Douglas (Kingswood) Ltd.

* * *

"Protection by Plysu" is publication No. 15 of Plysu Products Ltd., Woburn Sands, Bletchley, Bucks., to describe their range of pressure ventilated clothing, first introduced to provide light, comfortable and inexpensive protection from radioactive dust in certain sections of the United Kingdom Atomic Energy Authority. Advantages of the clothing are lightness of weight and complete air conditioning for the wearer. The clothing will have applications in industry, particularly where airborne contamination such as toxic smoke, gas or dust particles present a hazard. The clothing is made of P.V.C., and each garment is pressure tested. Air supply equipment illustrated in the brochure was designed for use with the pressure ventilated clothing by Spembly Ltd., of Manor Road, Chatham.

* * *

"Spray Equipment" is catalogue No. 459 of H. T. Watson Ltd., Croft Street, Widnes, Lancs. As modern industrial processes become more precise, increasing importance is laid on the efficiency of plant. The considerable range of spray nozzles shown in this catalogue, each produced to meet some specific requirement, emphasises the need for care in the choice of suitable nozzles. In a comprehensive introduction, some of the problems to be overcome in selecting a nozzle for a purpose are described, and at the end of the catalogue there are useful tables connected with flow measurement.

* * *

"Bonderizing" is a booklet produced by The Pyrene Co. Ltd. (Metal Finishing Division) to describe the range of processes for the treatment of iron, steel, aluminium, zinc and cadmium surfaces.

Although the process is normally applied in a hot Bonderizing solution, a reference is included to describe the spray-gun or brush application, and a description is also included of a process that gives a lightweight coating intended primarily for such items as office furniture. Address of the company is: Great West Road, Brentford, Mddx.

* * *

A catalogue sheet recently issued by the Micrometrical Mfg. Co., 345 South Main Street, Ann Arbor, Michigan, U.S.A., describes the Microrecorder, an electro-mechanical instrument that provides a permanent magnified chart of the roughness profile of a surface.

The instrument can be moved from place to place within the production department or laboratory, and set-up in any convenient spot close to the parts to be measured.

It is particularly useful for studying surfaces which are pitted, porous, have flaws or other irregularities.

"Athlone" students in London

THIRTY-FOUR young Canadian engineers, mostly graduates from Canadian universities, arrived in London recently under the Athlone Fellowships scheme. Here, at a reception given at the Ministry of Education in London, the Minister, Mr. Geoffrey Lloyd (right), enjoys a chat with some of the students.

Since the scheme started eight years ago, about 350 students from Canada have been able to spend two years in the U.K. doing post graduate studies in universities, technical institutions and engineering works.

Latest Developments in PLANT, PROCESSES AND EQUIPMENT

Hot Spray Cup

A HOT spray cup which has been introduced by the Aerograph-DeVilbiss Co. Ltd., 47, Holborn Viaduct, London, E.C.1, is designed to offer the advantages of hot spray painting to the small paint sprayer. (Fig. 1).

These advantages are said to include better flow out in any weather; the elimination of runs, sagging and orange peel; considerable reduction in overspray; quicker drying of the finish; a heavier coating in a single pass; and a higher gloss finish without rubbing down.

The cup will hold a quart of paint, and has a ¾-in. B.S.P. thread for fitting to most industrial suction feed spray guns, but adaptors are available at a small extra cost for use with other guns of this type with a different thread size.

After the cup has been filled with paint, it is plugged into an ordinary 210 V. to 250 V. A.C. supply, provided that the point is situated well away from the spraying area. The paint is allowed to heat up for 7 min., after which the electric lead can be disconnected and the cup attached to the gun; the cup is insulated to retain its heat during spraying.

Cellulose lacquers, synthetic enamels, primers, surfacers and undercoatings can be sprayed with the cup.

Fig. 1.—A hot spray cup allows preheating of the paint prior to spraying.

Rotary Screw Compressor

A PORTABLE rotary screw compressor is being marketed by Holman Bros. Ltd., Camborne, Cornwall.

Known as the "Rotair," it is a compact light weight machine delivering compressed air free from pulsation. The compressor consists essentially of two helical-fluted intermeshing rotors mounted in one casing. As they rotate, air is drawn through the inlet port to fill the interlobe space. The air is then trapped and compressed with a progressive reduction in volume space until released into the discharge port of the compressor.

The male rotor, which has four lobes, absorbs practically all the power required by the compressor. The female rotor, which has six lobes, functions as a rotary valve resulting in a continuous piston effect.

In this portable application, high efficiency is achieved in a single stage by oil-cooling that results without the use of inter- and after-coolers in air being delivered at temperatures at least 100°F. less than those obtained from conventional compressors, the makers claim.

The Holman Rotair range, giving outputs of 135 to 600 cu. ft. per min. can employ a variety of diesel prime movers.

Principal features and advantages claimed

The Rotair is able to function at more than double the speed of the driving engine, and step-up gearing gives a maximum compressor speed of 4,000 r.p.m.

Reciprocating and vane type machines usually employ two stages to obtain the desired built-in compression ratio ; the Rotair can obtain a similar ratio easily in one stage, the makers say.

The air flow through the compressor has axial flow characteristics and only the delivery end of the machine is subjected to high pressure. The rotors are located by matched pairs of combined journal and thrust bearings at the delivery end and expansion is provided for at the opposite end by standard roller bearings.

Cooling and sealing is made by injecting lubricating oil into the compression chambers ; detergent oil of the correct grade can be employed, as there are no vanes or other wearing parts to be considered. The form of rotors is such that hydraulic locks are impossible and, because of the

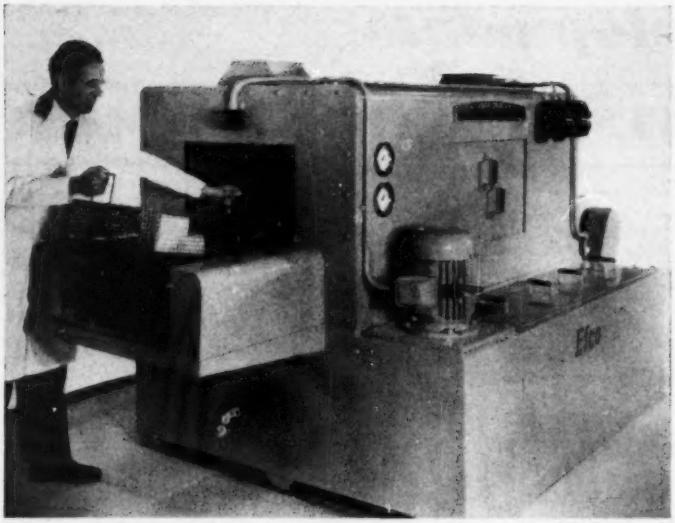


Fig. 2.—Metal cleaning equipment.

absence of sliding frictional elements, the oil life is much longer than in many other types of compressor.

Friction is reduced because the rotors have positive clearances within the stator casing, and the only friction is that between the engaging helices of the rotors. Since interlobe loading between the rotors is very light, and also because of the existence of the cooling fluid, this rolling engagement results in only very small losses. The stator casing is therefore non-wearing, there being no metal to metal contacts, whereas stator casing and vane wear on other compressors can be constant and considerable.

The total number of moving parts in the basic compressor is only six, comprising two rotors and four bearings. With these few parts maintenance is negligible and the compound oil pump can be renewed as an independent unit, quickly and easily.

Output of compressed air is controlled automatically according to demand by a simple mechanism that slows the engine down until the compressor is ultimately off loaded. This is brought about by controlling the inlet volume at the intake of the compressor.

Metal Cleaning Equipment

A NEW range of standard industrial spray washing equipment has been introduced by the Electro-Chemical Engineering Co. Ltd., Woking, Surrey. The range comprises single- and two-stage machines fitted with either mesh belt, flight bar or overhead monorail conveyors. All can be supplied with drying sections if required, and incorporate several features not usually available in standard industrial cleaning equipment. Particular attention has been given to those design aspects affecting accessibility, maintenance, and safety (Fig. 2).

In operation, the parts to be cleaned are loaded on to the conveyor and carried through a steel canopy where they are sprayed from all sides with a pump-circulated cleaning agent from stainless steel nozzles adjusted to give a maximum coverage of the work.

Full width, roller-mounted sliding doors and a translucent glass fibre roof hatch improve access to the canopy interior. Vertical monoblock pumps are employed which eliminate external pipework and gland spillage. The two canopy openings are provided with internal lip extraction ducts, connecting into fume extraction stubs mounted on top of the machine.

Emergency stop buttons are fitted to each end of the conveyor, and the drive mechanism is fully guarded.

The solution tank is fitted with removable covers and a quick-release door, with a space between the tank bottom and the shop floor to give access for hosing down. A quick-filling water service connection is provided, with a float valve to maintain the cleaning agent at constant level during operation. An overflow weir prevents overfilling and enables floating contaminants to be removed from the surface of the cleaning agent : a sloping bottom and drain sump allow complete emptying of the tank.

Pump output is rated to permit solids to settle before recirculation of the cleaning agent, and delivery is controlled by a hand valve : the suction side is protected by detachable strainers. The pressure and temperature gauges are flush mounted in a sealed chamber, which protects them from physical damage and ingress of water vapour. All exposed metal parts of the machine are phosphated and painted. Heating is by gas, HPHW, steam or electricity : thermal insulation is available as an optional extra.

The standard range of sizes includes conveyor widths of 18 in., 24 in. and 30 in. for the belt and flight bar machines. Variable speed drives and special heavy duty conveyors are available as optional extras.

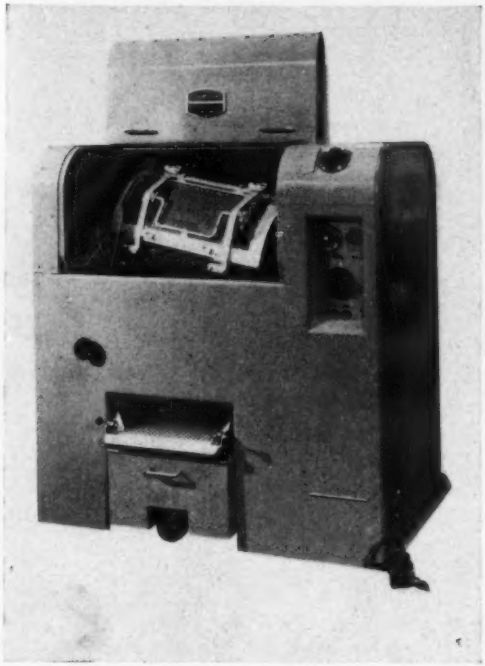


Fig. 3. (left)—A barrelling machine with a "built-in" separator.
Fig. 4. (above)—A degreaser with a fully automatic process cycle, made by the same company.

Barrel Finishing and Degreasing Machines

THE "Polymotion" barrelling machine, illustrated in Fig. 3, has a mechanical separator built in. After the barrel process is completed the load is tipped into a PVC lined hopper and the separator starts. The outlet from the hopper is controlled by a hand-wheel at the front of the machine that opens a flap to allow a continuous flow of media and parts on to the screen. The usual transfer by hand or hoist is eliminated, and both barrelling and separating are done in one machine, thus saving floor space. Makers are Fox Chemical Engineering Works Ltd., Maybury Gardens, London, N.W.10.

Separating after barrelling is sometimes made difficult by the incongruous shapes of barrelling media. The company are now marketing a full range of "Finesse" chips, manufactured to exact size and shape to facilitate separation.

The new Perfix Degreaser combines 2 stages in one compartment (Fig. 4), with a fully automatic process cycle from the time when parts are first lowered into the barrel until the parts are ready to be lifted out again. The interlocked lid makes it impossible for the operator to remove parts before they are properly degreased and dry, and avoids any drag-out of solvent. The barrel is useful for all cup-shaped parts and for those with recesses that might otherwise retain solvent. The same machine is also made without the barrel, either for big components or for use with baskets. The parts are first subject to a hot spray for a pre-set time, and a vapour then finishes the process.

Metal Cleaning Chemicals

MANUFACTURERS of many types of cleaners and detergents, Laporte Chemicals Ltd., Hanover House, 14 Hanover Square, London, W.1, have recently introduced the Metklens range of metal cleaning products. These are designed to meet a wide variety of needs, the following being some which are particularly worth of note.

Metklens 22 is a non-caustic detergent for cleaning ferrous and non ferrous metals. It can be used in all existing types of cleaning plant and has a long lease of life under actual working conditions.

Metklens 25 is a heavy-duty cleaner for ferrous materials, capable of removing extremely heavy soiling. Under certain conditions, limited carbon removal can also be effected.

Metklens 32 is a solvent emulsion degreaser suitable for degreasing ferrous and non-ferrous metals, the major point of interest being that this material confers a fine protective film to cleaned articles, thus preventing subsequent corrosion.

Metklens E3 is a universal electrolytic cleaner which can be used hot or cold on ferrous and non-ferrous parts; in addition, either anodic or cathodic cleaning can be employed.

Metklens DR1 is a powder type derusting product, claimed to be very economical in use and exceptionally fast in action. Under recommended conditions Metklens DR1 can be employed for removing heat and welding scale.

The company also have available non-foaming counterparts of the detergents described above, and most of the products conform to the applicable A.I.D. specifications.

Large Size Variable Flow Indicators

THE range of the "Arkon" variable flowin dicators made by Walker Crossweller and Co. Ltd., Cheltenham, has recently been extended to include sizes 1¼ in., 1½ in. and 2 in., in addition to the existing ¼ in., ¾ in. and 1 in. The instruments can be adjusted for either high or low velocities.

The principle of cartridge construction is applied in these instruments; the complete cartridge assembly is interchangeable between the different sizes. The spindle impeller assembly, fitted in a cartridge housing, is easily removed and reset for the required flow range. (Fig. 5).

The indicator itself is simple and reliable and shows at a glance whether flow is taking place. A chromium plated ring at the top of the spindle under a toughened glass dome ceases to spin when the flow through it stops.

The indicators are commonly used to indicate the flow of water, lubricating oil, cooling oil, and other liquids.

Viton Diaphragm in Flow Metering Unit

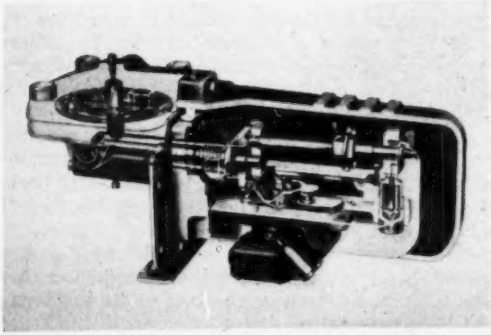
A NEW high-performance diaphragm has been fitted to the differential converter transmitters made by Honeywell Controls Ltd. for metering flow and liquid levels.

The "pneumatic balance" differential converter, which previously contained a Fluon-coated diaphragm separating high and low pressure chambers, now uses "Viton" as a diaphragm coating (Fig. 6).

The company says that the new diaphragm provides better long-term stability of measurement and higher stability under varying temperatures.

The chemical resistance of the new diaphragm enables it to be used to meter alkalis, amines, hydrocarbons and dilute or concentrated mineral acids. The Teflon-coated diaphragm remains available optionally for metering substances that might attack the Viton diaphragm.

Further details are available from the manufacturers : Honeywell Controls Ltd., Ruislip Road East, Greenford, Mddx.



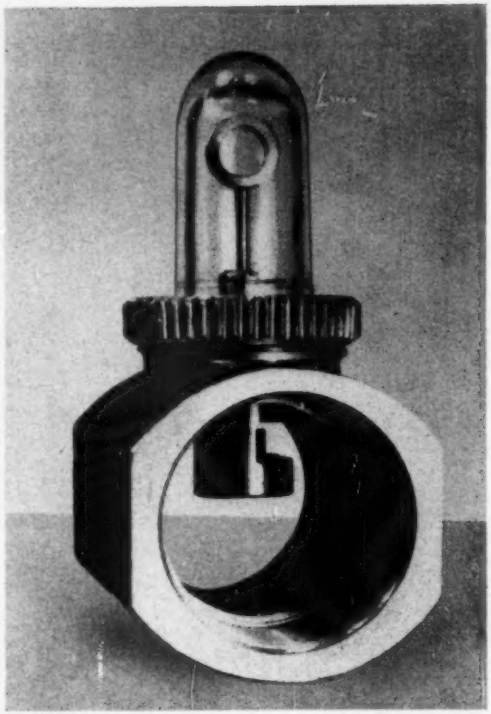


Fig. 5. (above).—Latest addition to a range of variable flow indicators.

Fig. 6. (below).—A Viton-coated diaphragm is used in this flow metering unit.

Rigid Foam Spray Process

A NEW polyether resin, "Daltolac 41," is specially designed for use with Suprasec D to produce rigid polyurethane foams by the spray process. The low-density (3-5 lb./cu. ft.) foams produced show excellent thermal insulation properties and have very good resistance to water uptake and water vapour transmission, the makers claim. They are admirably suited for the thermal insulation of roofs and walls, to which they are easily and conveniently applied by spraying. Only the normal precautions are necessary in such application. For this work the Daltolac 41/Suprasec D foams offer some economic and technical advantages as compared with conventional insulation techniques, and are expected to prove very attractive.

The makers of Daltolac 41 and Suprasec D, the Dyestuffs Division of Imperial Chemical Industries Ltd., have designed special equipment (now available commercially) for spraying the foams, which should find extensive use for the spraying of thermal insulation on open surfaces.

(*Continued in page* 30)

Plant, Processes etc.

(*Continued from page* 328)

Nylon Pressure Tubing

THE latest demonstration of the use of synthetic fibres in industry is provided by Wakefield-Dick Industrial Oils Ltd. who now market and fit " Nylon H " tubing, when required, to their mechanical lubricating equipment.

The tubing, being completely flexible, can be rapidly installed in otherwise inaccessible positions, and will withstand pressures of up to 2,500 lb. per sq. in.

The makers say that every foot of " Nylon H " tubing is subjected to a thorough testing at 77°F., is guaranteed against bend strain and damage by impact, and will not become brittle within the prescribed temperature range (—74°C. to 105°C.).

Wakefield-Dick supply " Nylon H " tubing in five sizes, with outside diameters from 0.125 in. to 0.375 in., and inside diameters from 0.078 in. to 0.225 in. respectively.

Lightweight Industrial Gloves

AN industrial glove recently introduced by James North and Sons Ltd., Kirkman House, 54a Tottenham Court Road, London, W.1, has been designed to give the wearer greater dexterity than can be obtained when using conventional P.V.C. gloves. Called " Plastichrome," the gloves are claimed to have far greater wearing capabilities than cotton, rubber or chrome palm gloves, and are mainly recommended for wet and dry handling and for all hazards of a light nature where traditional gloves are normally used. They are not intended to supersede the normal industrial P.V.C. gloves where these are used for acids and other hazardous chemicals. Available in four sizes and three types, the company says the gloves offer very substantial economies compared with traditional products.

Micro-hardness Tester

ARRANGEMENTS have been concluded by Nash and Thompson Ltd., Chessington, Surrey, for the marketing of the G.K.N. micro-hardness tester, manufactured by Associated Automation Ltd., Dudden Hill Lane, London, N.W.10.

This precision measuring instrument enables indentations to be spaced less than 0.001 in. apart. Small sections, foils as thin as 0.0005 in. and individual crystals or phases can all be checked. Using a 10 gm. load on a material with a hardness of 200 V.P.N. the diagonal dimension of the indentation is only approximately 10 microns, the makers say.

The micro-hardness tester can be supplied mounted to, and calibrated with, a bench-type metallurgical microscope.

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